RIVER OTTER [*LUTRA CANADENSIS*] HABITAT UTILIZATION IN NORTHWESTERN ILLINOIS

FINAL REPORT

River Otter (*Lutra canadensis*) Habitat Utilization In Northwestern Illinois

Submitted by CWRL, SIU-C

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ABSTRACT

A study was conducted from August 1982 - December 1983 to identify and characterize critical areas of river otter (Lutra canadensis) habitat along and nearby the Mississippi River in northwestern Illinois; to determine seasonal utilization of an example of such habitat; and to assess potential impacts of the various resource uses on the otter population in these areas. An additional objective was to evaluate what effect, if any, water level fluctuations may have on habitat utilization. Two male otters were livetrapped, each surgically implanted with a radio transmitter, and released. Monitoring of habitat and den selection by these otters using radio telemetry and that of other otters, including a small family group, through field observations identified seasonally the type of areas used. Habitats used by otters had several characteristics in common: (1) isolation from the main channel; (2) riparian habitats of extensive woodlands; (3) good water quality; (4) areas of open water in winter; and (5) presence of suitable den sites. Evaluation of habitats along the Mississippi River bordering Illinois, southeastern Iowa, and northeastern Missouri resulted in identification of 13 areas of critical otter habitat. Commercial transportation, furbearer trapping, and commercial fishing were all found to negatively impact otters. Also, high water levels during March and April may adversely effect otter recruitment and therefore be a potential population limiting factor. Analysis of 765 otter scats indicated fish were principal prey with Centrarchidae, Cyprinidae, and Clupeidae occurring in 49%, 41%, and 36% of the scats, respectively. Amphibians, crustaceans, insects, and birds were of lesser importance. Management recommendations

include: (1) preservation and enhancement of existing and potential habitat; (2) establishment of a suitable monitoring system for the river otter in Illinois; (3) restrictions in furbearer trapping regulations and closing of critical areas to provide greater protection for the remnant otter population; and (4) continued information and education programs regarding the river otter's status in Illinois. Listing of the river otter as an "endangered" species seems warranted.

INTRODUCTION

The river otter (Lutra canadensis) is currently listed as a "threatened" species in Illinois. It is recognized that little was known of the status and distribution of the river otter in Illinois when that status was assigned. Since that time, 3 attempts have been made to document distribution or determine status. In 1977, an initial effort by the Illinois Nature Preserves Commission documented recent records of otter occurrence (Thom 1981). A mail survey of commercial fishermen in 1978 (G. F. Hubert Jr., unpubl. data) and Illinois Department of Conservation (IDOC) personnel in 1979 (G. F. Hubert Jr., unpubl. data) was made by the IDOC.

The Cooperative Wildlife Research Laboratory (CWRL) during January 1981 - June 1982 documented the current status and distribution of the river otter in Illinois based on unpublished reports, literature, and reports of confiscations that yielded 68 records of otters (Anderson 1982). In addition, 57 previously unrecorded reports of river otters were collected; that, with the recorded reports, indicated a sporadic occurrence throughout much of Illinois. Seemingly, the major portion of the population occurred along the Mississippi River from the Wisconsin border south to about Rock Island (Fig. 1). A smaller population existed in southern Illinois centered along the Cache River in the Heron Pond - Little Black Slough area. Field surveys associated with this study yielded observations of otter sign at 6 sites during the summer 1981 and 4 sites during winter 1982 along the Mississippi River in northwestern Illinois and adjacent areas of Iowa. Most sites of otter activity were located along tributaries or along narrow backwater channels.

Figure 1. Proposed distribution of the river otter in Illinois (From Anderson 1982), Wisconsin (From Knudsen 1956), Iowa (From Bowles 1975), Missouri (D. Erickson, pers. commun.), Kentucky, and Indiana.

All sites were located in or near areas of extensive bottomland woods and where not covered with woods the ground was well vegetated, primarily with tall grasses.

Because little was known of the habitat utilization by the remnant population of river otters along the Mississippi River in northwestern Illinois, additional information was needed to provide data upon which to implement research and management programs where appropriate. The present investigation involved an effort to identify and characterize critical otter habitat along and nearby the Mississippi River in northwestern Illinois, and to determine seasonal utilization of an example of such habitat. An additional objective was to assess potential impacts of the various resource uses on the otter population. To obtain this information, a study was conducted to locate and livetrap a family group of otters (female and her young) and surgically implant a radio transmitter in each. Capture of a family group was not possible, so attempts were made to capture any otters in the vicinity of the proposed study site. Their movements and denning activities were monitored to identify the type of areas utilized, thus, defining critical components of otter habitat. Field surveys and cover mapping then identified "critical" otter habitat.

STUDY AREA

The area immediately below Mississippi River Lock and Dam 13 (Fig. 2) was selected for intensive study due to ease of access and past reports of otter utilization (Anderson 1982). The 220 ha area located north of Fulton in Whiteside County, Illinois was developed during the past few years (C. Jacobs, landowner, pers. commun.). Prior to 1962, Lake 4 was a narrow ditch draining farmland to the east. In 1962, the landowner contracted the excavating of land bordering the ditch to create a shallow lake (about 1.0 m or less in depth) which formed the existing shoreline. These conditions existed until about 1976 when construction was begun on a levee through the area (Fig. 2) as part of a Mississippi River flood control project. During this project, which continued for 3 years, portions of Lakes 3-5 were used as borrow pits to obtain material for levee construction. This action greatly increased lake depths resulting in present maximum depths of 4.3, 9.1, and 7.0 m for Lakes 3, 4, and 5, respectively. Lakes 1 and 2 had maximum depths of about 1.0 m. The southern length of the levee was built over the bed of an abandoned railroad spur bordered by mixed hardwoods. During levee construction, those trees averaging more than 6.1 m in height were cut and placed into large piles (8-12 m wide) along the lake shores (Fig. 2). Today, the area is predominately mixed lowland hardwoods, principally silver maples (Acer saccharinum) and scattered cottonwoods (Populus deltoides), with an average height greater than 6.1 m. Most of the area north and west of the levee is part of the Upper Mississippi River Wildlife and Fish Refuge; the remainder is privately owned.

The area receives moderate hunting pressure for waterfowl with

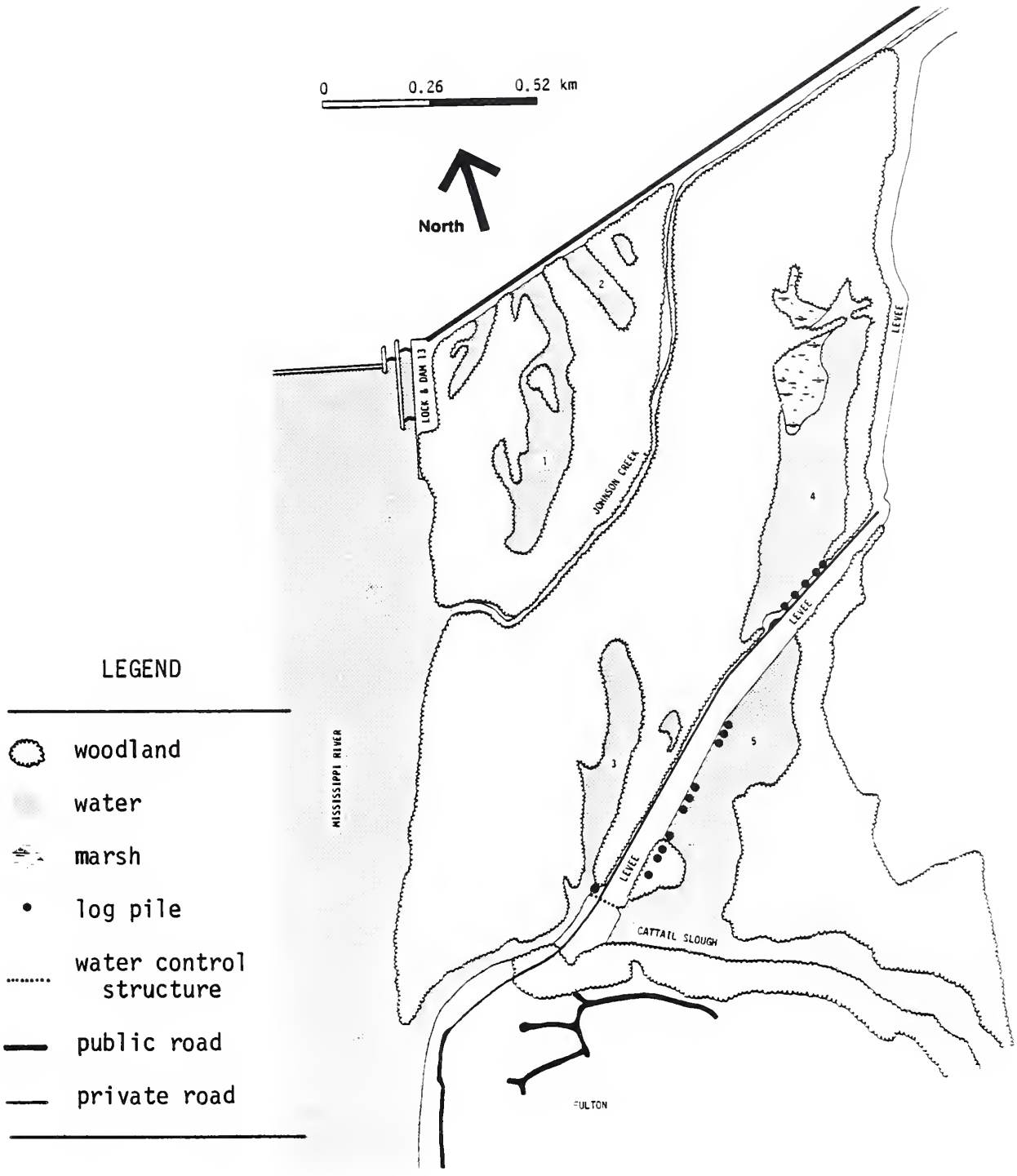


Figure 2. River otter intensive study area north of Fulton, Illinois.

Lakes 1, 4, and 5 containing 3, 2, and 1 blinds, respectively. Both refuge and private lands are open to deer hunting. Lakes 1, 2, and 3 receive moderate fishing pressure while Lakes 4 and 5 receive light to moderate fishing pressure. In addition, Lakes 3-5 are used for commercial fishing; and, according to C. Jacobs, a commercial fisherman (pers. commun.), common fish species are those typically associated with the Mississippi River: gizzard shad (Dorosoma cepedianum), carp (Cyprinus carpio), white bass (Morone chrysops), buffalo (Ictiobus spp.), sunfish (Lepomis spp.), and catfish (Ictalurus spp.). During 1982, furbearer trapping was restricted on private land bordering the levee; and, only 1 trapper was known to trap Lakes 3 and 5 with raccoon (Procyon lotor) the target species. All refuge land was open to trapping.

MATERIALS AND METHODS

Field Surveys

Field surveys began 12 October to examine riparian habitats and note otter field signs to locate a family group. By periodically searching the study area, it was possible to monitor otter movements and seasonal habitat utilization. River otter scats were collected; number and location of scats were used to estimate activity in a given area. Frequent, and often daily, visits were made to the study area, especially to known otter haul outs. All available scats were collected during these visits, so, scats were often fresh and and age of older scats could be approximated based on date of last visit and condition. Scats were stored in plastic bags and frozen for later analysis.

Criteria for recognition of otter field signs followed Mowbray et al. (1979); additional descriptions were obtained from Grinnel et al. 1937, Greer 1955, Schwartz and Schwartz 1959, Jackson 1961, Erlinge 1967, Park 1971, Murie 1974, and Melquist and Hornocker 1979. According to Stephens (1957), the footprints of otters usually vary according to age and sex; so, measurements were taken of tracks encountered during periods of snow coverage in January and February. Melquist and Hornocker (1979) listed 14 possible solitary and group associations in which otters may occur during the breeding and non-breeding periods. Using this information and measurements of tracks, it was possible to interpret some tracks observed. Photographic records (35 mm color slides and black and white prints) of riparian habitats and otter field signs were made.

Livetrapping

Livetrapping of otters was attempted with a variety of traps: 5 Hancock livetraps, 3 Bailey livetraps, 2 box traps (122 cm x 30 cm x 41 cm), 1 No. 7 Havahart livetrap, 1 floating trap, and No. 3 longspring and No. 2 coilspring leg hold traps. Hancock livetraps were modified according to recommendations by Northcott and Slade (1976) and Melquist and Hornocker (1979). The floating trap was built to specifications of Melquist and Hornocker (1979). The No. 3 leg hold traps had offset jaws which were padded with twine or burlap to reduce the possibility of injury to captured animals. Three swivels were added to each trap chain to prevent tangling and some chains were equipped with 42 cm x 1 cm springs to further reduce the possibility of injury. Fresh fish or canned sardines were used as bait in the Havahart livetrap and box traps; live fish were used in the floating trap.

Care and Handling

River otter handling equipment including a holding pen and drugging/nest box were constructed approximating specifications given by Melquist and Hornocker (1979). The holding pen consisted of an indoor section (2.2 m x 2.0 m x 1.8 m) connected by a 23 cm diameter culvert 140 cm long to an outdoor section (3.2 m x 1.8 m x 1.1 m). Both sections were constructed with vented, galvanized steel sheets. The indoor section was covered with corrugated steel sheets and the outdoor section with 0.95 cm diameter rod panels.

In general, care and handling of captured river otters followed techniques described by Melquist and Hornocker (1979). Implant procedures

followed those outlined by Melquist and Hornocker (1979) except Rompun (Xylazine) was used at a level of 3 mg/kg in conjunction with ketamine hydrochloride for surgical anesthesia. Also, as recommended by D. Erickson (Wildl. Res. Biologist, Missouri Dept. of Cons., pers. commun.), the otter were held for a minimum length of time; in this case, 24-48 hours.

Radio Telemetry

Radio telemetry locations of instrumented otters were made with a small "H" directional antenna which was either hand-held of mounted to the roof of a vehicle. When ground searches failed to locate the otters, a helicopter with "H" antennas mounted to legs on both sides or a Cessna 172RG with antennas mounted to each wing strut was used. Maximum ground-to-ground range was about 0.8 km but generally was much less due to obstructions such as vegetation, rocks, and soil. Maximum air-to-ground range was about 2 km while flying at 400 m above the ground with the helicopter and 9.6 km while flying at 800 m above the ground with the airplane.

River otter M1, due to its extensive movements, was monitored only with the airplane. Search procedures included following the Mississippi River and adjacent waters north from either St. Louis, Missouri or Quincy, Illinois until transmitter location was made. Multiple low-altitude fixes were made for a precise location. River otter M2 was monitored on a daily basis with location, den site, and habitat being recorded each time it was found.

Cover Mapping

Cover type mapping of the intensive study area and other sites utilized by river otters along the Mississippi River in northwestern Illinois and adjacent areas of Iowa during winter 1982 was done using the cover type classification scheme (Appendix 1) and mapping by Hagen et al. (1977). Mapping by Hagen et al. (1977) which utilized 1975 aerial photography (1:24,000) for remote sensing was updated using 1979 aerial photography and ground truthed during field surveys. Depths of lakes were determined by sounding with a metered rope and weight; depths were adjusted to normal pool levels.

Critical Habitat

Critical areas of river otter habitat along that portion of the Mississippi River bordering Illinois, southeastern Iowa, and northeastern Missouri were identified and evaluated based on field survey and radio telemetry data and criteria for good otter habitat described by Bottorff et al. (1976) and Goodman (1981). Baseline information on suitable habitat and past reports of otter utilization from Anderson (1982) were also used. Critical areas were located using aerial photographs, topographic and geological maps, and Mississippi River navigation charts.

Food Habits

Otter scats collected during the study and utilized as an estimate of otter activity on the study area were also used to determine feeding habits. Prior to analysis, scats were removed from storage bags, placed

in paper cups, and air dried. Dried scats were examined under a dissecting microscope to identify prey remains. Fish scales were identified according to Lagler (1947). Mammal hairs were soaked in xylene for 30-45 minutes, mounted on slides, and identified according to Spence (1963) and comparison with a reference collection on file at the CWRL. No attempt was made to identify order, family, or species of birds.

Food habits data were tabulated by frequency of occurrence and analyzed per season and location within the study area. Frequncy of occurrence was expressed as a percentage of the total for a given season and location and as a percentage of the overall total for the study area.

RESULTS

Seasonal Habitat Utilization and Characterization

Fall

Several otters were utilizing the study area at the beginning of field surveys in October. On 18 October, fresh otter scats were found at haul outs located on log piles on Lake 4 (Fig. 3); and, at about 1000 hours, an otter was sighted near one of the log piles. On 27 October, 3 otters, believed to be a family group, were sighted by fishermen on this lake. This was considered the minimum number occupying the study area until 28 November when a juvenile otter, probably of this family group, was accidentally caught by a trapper on Lake 3. Scat evidence (Table 1) indicated Lake 4 (Fig. 4) was the center of river otter activity during October and November when over 75% of the scats were collected there. Most scats were associated with haul outs (Fig. 3) and probable den sites located on log piles along the lake shore (Fig. 4). Lakes 1, 3, and 5 were utilized little by otters; other areas received no apparent use (Table 1).

The study area was characterized by diverse aquatic habitats and vegetative cover types (Appendix 2). Lake 4, the center of fall otter activity, was characterized by deep, relatively clear water bordered on the north by extensive areas of shallow water supporting dense stands of emergent vegetation, primarily cattail (Typha latifolia) and smartweeds (Polygonum spp.). The log piles along Lakes 3, 4, and 5 were key habitat components as evidenced by haul outs and probable den sites. Isolation from the Mississippi River resulted in less severe fluctuations in water levels in Lakes 4 and 5; thus, preventing inundation of den

Table 1. Location, number, and frequency of occurrence to nearest percent of 765 river otter scats collected from the intensive study area north of Fulton, Illinois; October 1982 - June 1983.

	Fall		Winter			Spring			Summer
Location	October	November	December	January	February	March	April	May	June
Lake 1	8(13)	0(0)	20(28)	0(0)	2(2)	0(0)	16(19)	6(17)	0(0)
Lake 2	0(0)	0(0)	4(6)	6(5)	3(3)	0(0)	14(17)	0(0)	0(0)
Lake 3	2(3)	10(11)	15(21)	48(38)	58(48)	38(24)	16(19)	9(25)	8(50)
Lake 4	54(84)	69(77)	19(27)	2(2)	35(29)	67(42)	17(20)	7(19)	0(0)
Lake 5	0(0)	11(12)	5(7)	0(0)	0(0)	27(17)	17(20)	10(28)	8(50)
Johnson Creek	0(0)	0(0)	8(11)	60(47)	9(8)	23(15)	3(4)	4(11)	0(0)
Mississippi River	0(0)	0(0)	0(0)	11(9)	13(11)	3(2)	0(0)	0(0)	0(0)
Totals	64(8)	90(12)	71(9)	127(17)	120(16)	158(21)	83(11)	36(5)	16(2)

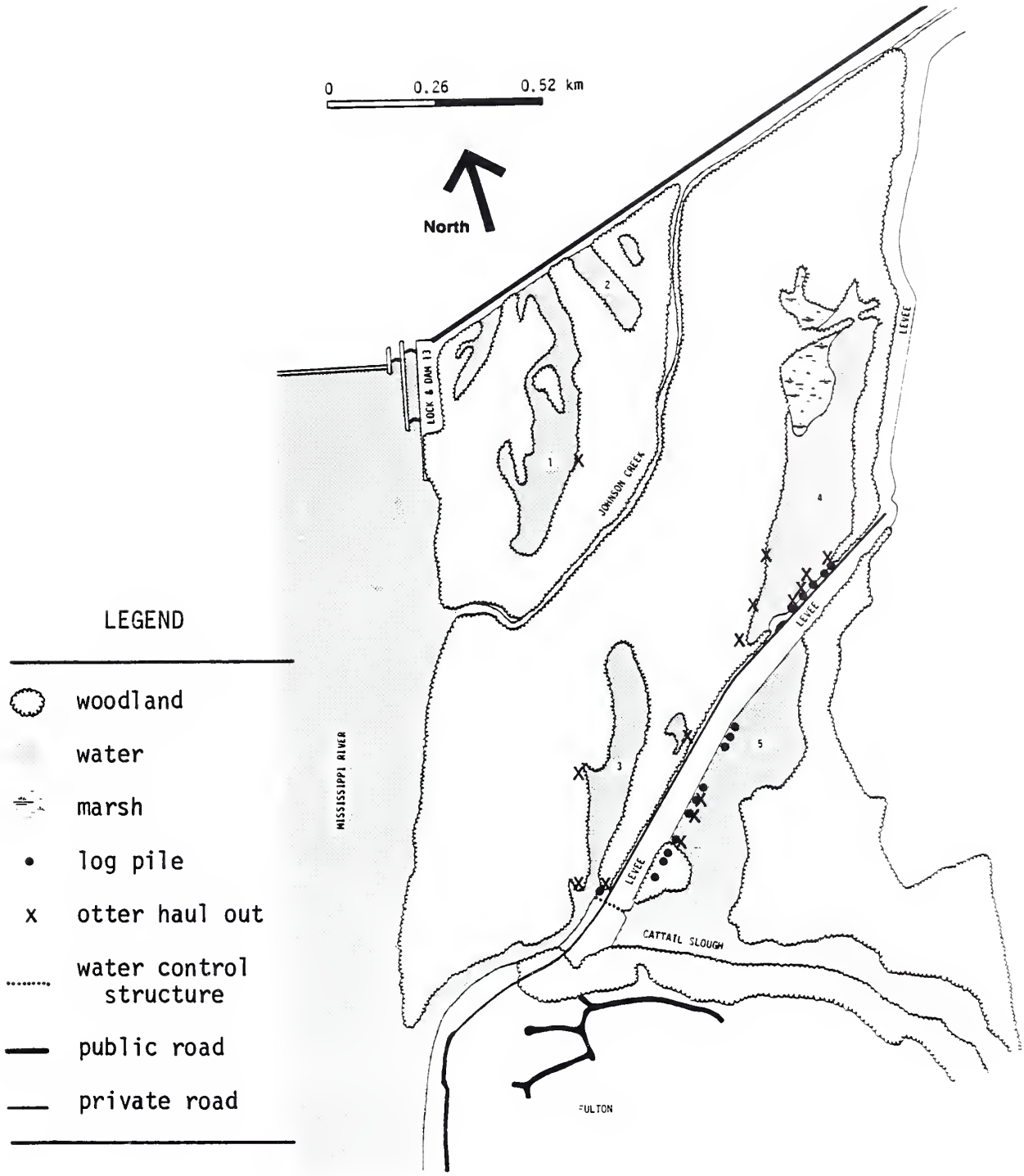


Figure 3. River otter intensive study area north of Fulton, Illinois; fall 1982.

Figure 4. Lake 4, a backwater lake along the Mississippi River, was the center of river otter activity during fall 1982 on the intensive study area north of Fulton, Illinois. Log piles were frequently used as otter haul out and den sites (9 December 1982; River Stage: 12.0 feet).

sites except during extremely high water stages. This was evident during the latter part of November when high water inundated much of the land surrounding Lakes 1-3. Further, this isolation resulted in a pronounced increase in water clarity in these lakes due to separation from turbid waters of the Mississippi River. Water clarity was particularly good on Lake 4 due to the natural topography of the area and the remains of several small levees bordering Johnson Creek such that direct connection with the river only occurred during high water stages via a shallow slough on the southwest tip of the lake. Water clarity of Lake 5 was good due to separation from the river by the levee; however, during periods of heavy rainfall, connection with Cattail Slough which originates as a drainage ditch increased turbidity of the lake and resulted in water level fluctuations. Direct connection with the river was regulated by a water control structure located on the levee (Fig. 3).

Winter

Several otters continued to utilize habitats within the study area during winter. On 4 February, 3 sets of otter tracks were observed: 1 solitary and 2 together. Measurements suggested the solitary set of tracks (rear track width: 9.8 cm) was that of an adult male otter while those of the pair (rear track widths: 8.2 and 7.3 cm) were probably those of a female and her pup. It was believed this pair represented the remainder of the family group occupying the study area during fall. Frequent movements of the otters between the lakes, creek, and river were noted throughout winter. Depending on location of otter activity, den

selection included sites in log piles on Lakes 3 and 4 and abandoned beaver (Castor canadensis) bank dens along Johnson Creek and Lakes 1 and 2 (Fig. 5).

Based on scat evidence (Table 1, Fig. 6), utilization of Lake 4, the center of fall otter activity, declined sharply through December into January when only 2% of the scats occurred there. Notable increases in activity occurred on Lake 3 and Johnson Creek during January (Table 1) when monthly occurrence of scats reached 38% and 47%, respectively. However, in February, activity declined on Johnson Creek to 8% while it increased on Lake 3 to 48%. Otter activity on Lakes 1 and 2, both shallow lakes (maximum depths about 1.0 m), peaked in December at 34% frequency of occurrence but remained at low levels (5% or less) during other winter months (Fig. 6). Activity on Lakes 3 and 4, both considered deep lakes (maximum depths: 4.3 and 9.1 m, respectively) was greater than all other areas except during January when exceeded by Johnson Creek (Fig. 6). Lake 5 and the Mississippi River border of the study area were utilized little by otters with monthly occurrences of 11% or less (Table 1, Fig. 6).

Study area habitats were previously characterized for the fall season; however, an important component of winter habitats not previously identified was the presence of open water. Winter 1983 was mild for northern Illinois; temperatures averaged -0.3 C or 3.8 degrees above normal (National Oceanic and Atmospheric Administration 1982, 1983). This resulted in considerable open water throughout the study area and along much of the Mississippi River. On the study area, open water existed as several small patches along the northeast edge of Lake 1, as a small area around the outlet of the water control structure of Lake 3

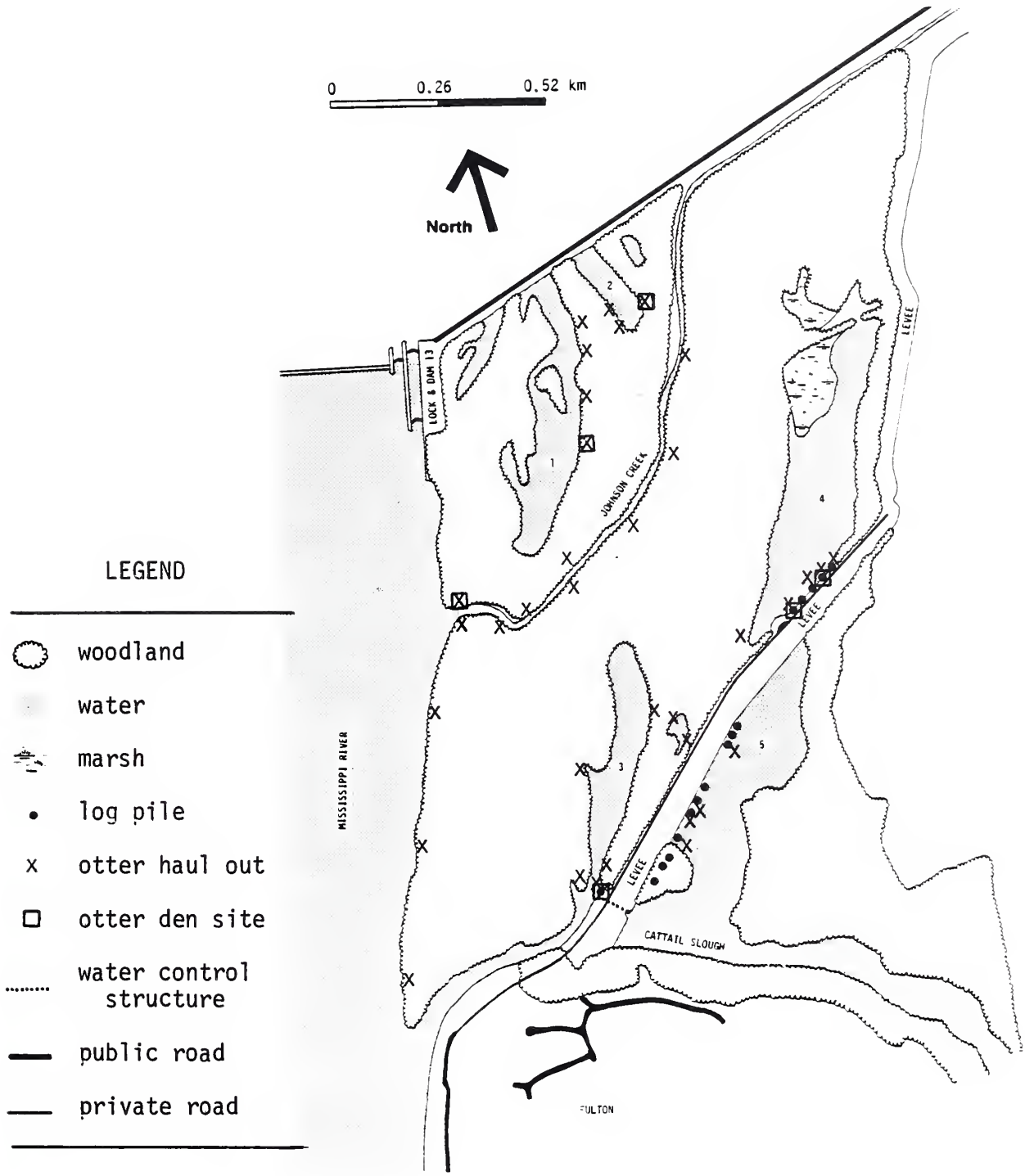
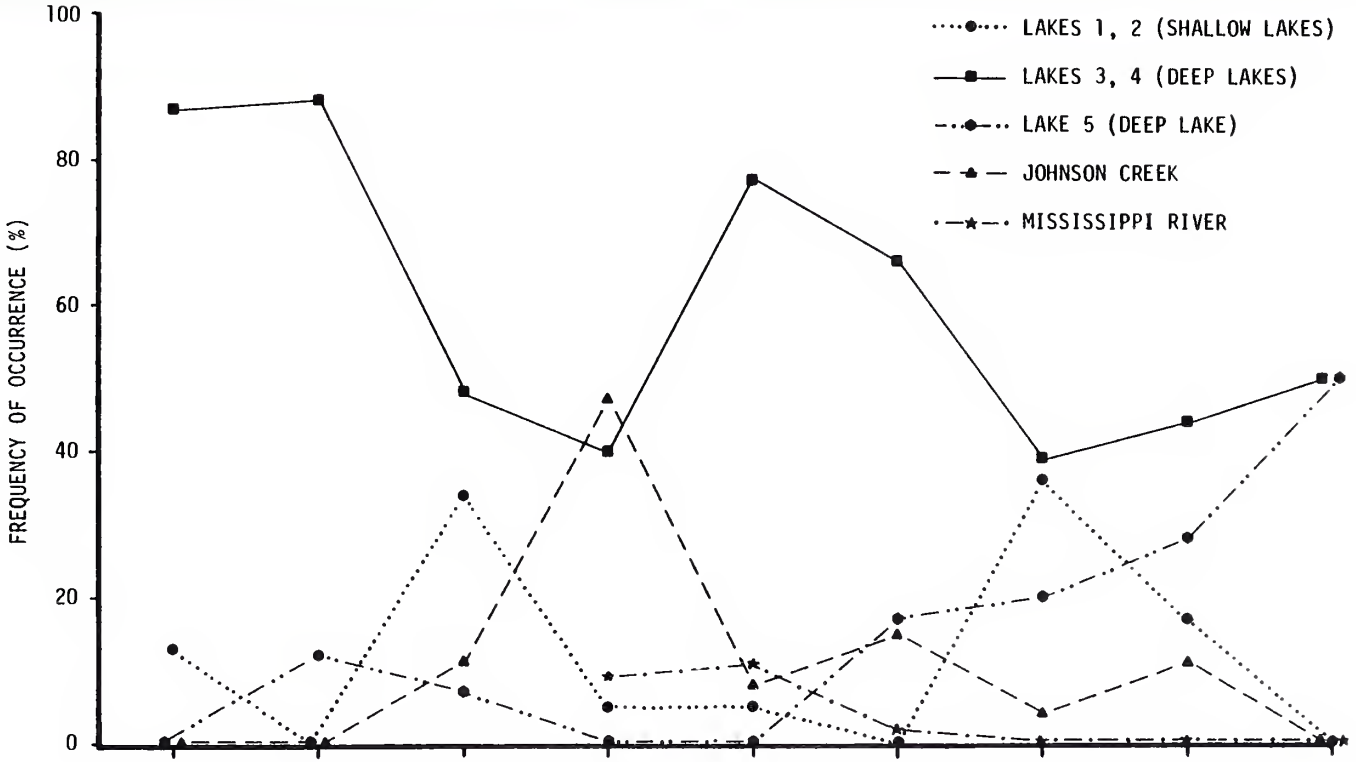


Figure 5. River otter intensive study area north of Fulton, Illinois; winter 1983.



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
NUMBER OF SCATS:	64	90	71	127	120	158	83	36	16
RIVER STAGE[a] -									
MEAN:	9.3	11.5	10.2	8.7	8.6	14.5	13.9	13.0	9.4
HIGH:	12.4	13.3	13.0	9.5	11.2	18.6	15.9	14.9	12.2
LOW:	7.0	9.4	8.4	7.7	7.0	9.5	12.2	12.4	8.2

[a] Monthly mean, high, and low Mississippi River stages in feet recorded at Clinton, Iowa; river mile: 518.0 (Rock Island District, US Army Corps of Engineers, unpubl. data).

Figure 6. Location and monthly occurrence of 765 river otter scats collected from the intensive study area north of Fulton, Illinois; October 1982 - June 1983.

(Fig. 7), across much of Lake 5, along most of Johnson Creek (Fig. 8), and along the entire stretch of the Mississippi River bordering the study area. Otter activity was concentrated around these sites, particularly, on Lake 3 and Johnson Creek.

During the severe winter of 1982, when temperatures averaged -7.2 C or 3.1 degrees below normal (National Oceanic and Atmospheric Administration 1981, 1982), the study area was also utilized by a group of otters. At that time, all lakes were ice-covered with the exception of the small areas on Lake 1 and a much smaller area on Lake 3 (Anderson 1982). Also, open water occurred along the northern bank of Johnson Creek and immediately below the dam on the Mississippi River.

Cover types of 3 additional sites of otter activity located along the Mississippi River in northwestern Illinois and adjacent areas of Iowa during the winter 1982 (Anderson 1982) appear in Appendices 3-5. On 4 February 1983, a field survey along Savanna Slough (Fig. 9, Appendix 4), located 22 km north of the study area, revealed several otters were again using the area. Signs were found along most of the slough and along the western levee of Spring Lake. This area contained no open water during winter 1982; however, during winter 1983, the entire length of Savanna Slough remained open. As on the study area, otter activity was concentrated along these open water areas (Fig. 9).

Spring

The night of 1 March or early morning of 2 March an adult male otter (M1), probably the one noted on the study area during winter, was livetrapped on the shore of Lake 3 (Fig. 10). The trap was situated at the end of a trail used by otters to travel between Lakes 3 and 4.

Figure 7. A small area of open water around the outlet of a water control structure on Lake 3 (Swedes Lake), a backwater lake along the Mississippi River, was frequently used by otters for foraging during winter 1983. The log pile (on right) was a preferred den site while the small point of land (on left) served as a haul out location (14 February 1983; River Stage: 7.7 feet).

Figure 8. Open water near the mouth of Johnson Creek, a tributary to the Mississippi River, was a preferred habitat for otters on the intensive study area north of Fulton, Illinois during winter 1983 (14 February 1983; River Stage: 7.7 feet).

Figure 9. Savanna Slough, a backwater slough along the Mississippi River, was site of river otter activity during winters 1982 and 1983. The slough contained extensive areas of open water, the preferred winter habitat of otters, throughout winter 1983.

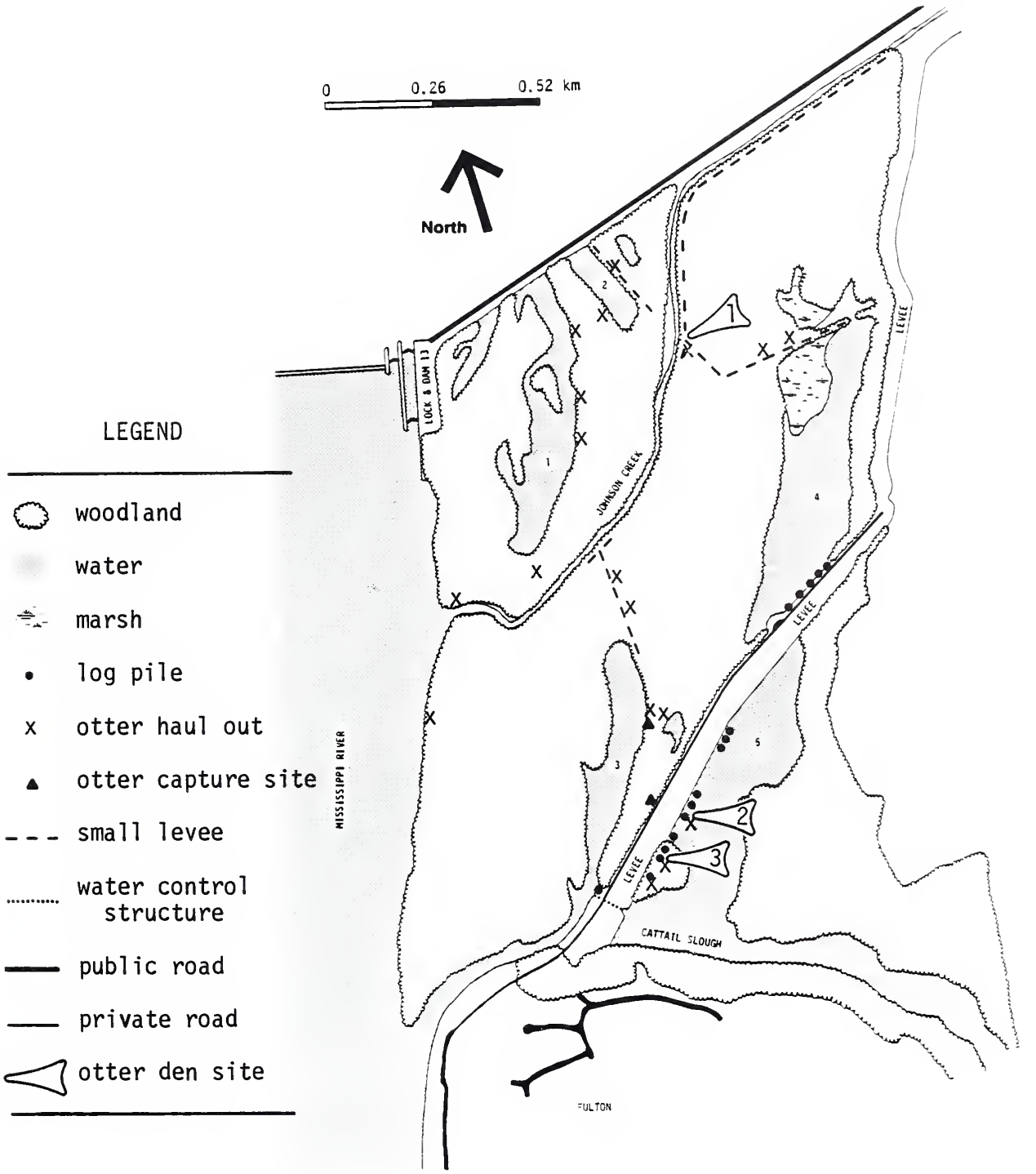


Figure 10. River otter intensive study area north of Fulton, Illinois; spring 1983.

Surgical implantation of a radio transmitter in the otter was performed on 2 March; and, on 4 March, the otter was released near the log pile on the south end of Lake 3. By the following day, the otter had left the study area.

Several otters continued to utilize habitats within and near the study area; and, on 22 March, following a snowfall of 10-12 cm, 6 sets of otter tracks were observed on the study area: 1 solitary and groups of 2 and 3 individuals. The solitary set of tracks was observed just north of the Lock and Dam 13 entrance road and crossed the road into Lake 1. Measurements taken from a solitary set of tracks along Johnson Creek and Lake 5 on 5 April and later dates suggested they (rear track width: 9.5 cm) were those of an adult male otter. The group of 2 individuals, believed to be the family group occupying the study area during fall and winter, appeared to den in an abandoned beaver bank den (Den Site 1) along Johnson Creek (Figs. 10 and 11). The group of 3 individuals consisted of similar sized otters (rear track widths: 8.2, 8.2, and 7.6 cm); they denned in the log piles (Den Sites 2 and 3) located along the northern shore of Lake 5 (Figs. 10 and 12). A male otter (M2) livetrapped 15 April at the base of the levee along Lake 3 (Fig. 10) was believed to be a member of this group as rear tracks made by the animal when released measured 7.7 cm. The otter was radio implanted on 15 April and the following day released near its probable den site on Lake 5. During the latter part of March and most of April, spatial distribution of the 2 groups was maintained; however, track evidence indicated the adult male otter moved throughout the study area. On 6 April, a notable decline in otter activity was observed around Den Site 1 (Fig. 10) suggesting 1 or the 2 otters in this group may have

Figure 11. Remains of a small levee (on left) along Johnson Creek (on right) was site of river otter activity during spring 1983 on the intensive study area north of Fulton, Illinois. Otter Den Site 1 was located on this levee (22 April 1983; River Stage: 15.4 feet).

Figure 12. Lake 5 (Wares Lake), a backwater lake along the Mississippi River, was site of river otter activity during spring 1983. Log piles along the shore and in the small woodland (on right) were preferred otter haul out and den sites (17 March 1983; River Stage: 17.9 feet).

left the study area; by 25 April, there was no sign of activity at this site. Continuous activity was noted around Den Sites 2 and 3 until 6 May. After this date, tracks of only 1 otter were observed; and, although this otter may have been on the area prior to this time, its tracks (rear track width: 7.4 cm) were first observed along Johnson Creek and Lake 3 on 11 May. Otter M2, which had tracks of similar width, left the study area on 19 April. Therefore, 8 different otters appeared to utilize habitats within the study area during various periods of this season; and, at least 6 otters simultaneously occupied the area.

Scat evidence (Table 1) supported track data and indicated river otter utilization of the study area peaked in March when 158 scats were collected. During March, assignment of scats to one particular area was somewhat arbitrary as haul out locations (Fig. 10), where most scats were collected, indicated foraging activity was concentrated in shallow, inundated areas adjoining the lakes and creek rather than the main bodies of water. Other scats were collected along trails used by the otters when crossing between bodies of water. Generally, otter activity was restricted to Lakes 3-5 and Johnson Creek with Lake 4 having highest monthly occurrence of scats at 42% (Table 1, Fig. 6). In April, otter activity was less concentrated as evidenced by increased utilization of Lakes 1 and 2 to 19% and 17%, respectively; however, utilization of Lakes 3-5 declined during this period (Table 1, Fig. 6). In May, Lakes 3 and 5 received highest utilization with 25% and 28%, respectively. From March through May, the Mississippi River border of the study area was utilized little or not at all be otters with monthly occurrences of 2% or less.

Due to high river stages, important habitat components of the study area during this season were suitable den sites located well above normal water levels. Past otter den sites in log piles on Lake 4 (Fig. 13) and Lake 3 were inundated with water during much of the spring. At this time, the remains of small levees near Lake 4 and bordering Johnson Creek (Fig. 11) and log piles in the small woodland on the northern shore of Lake 5 (Fig. 12) remained above water level and provided suitable den sites.

Summer

Track observations indicated only 1 otter remained on the study area in June; and, by 21 June, the last day of field surveys, no sign of otter activity was found. The decline in otter utilization of study area habitats was also evident in scat data (Table 1, Fig. 6) as only 16 scats were found. No habitat preference was noted during the limited field survey period as tracking indicated the otter wandered throughout the study area.

Livetrapping

As a result of 462 trap nights, 2 river otters were captured; one in a Hancock livetrap, the other in a Bailey livetrap (Table 2). While still in the traps, otters were drugged with an intramuscular injection of ketamine hydrochloride, then, placed in the drugging/nest box and delivered to the holding pen. Numerous captures of non-target animals were made; all were released unharmed with the exception of an opossum (Didelphis marsupialis) which suffered a broken front leg when caught in a leg hold trap. Beavers especially were a nuisance and several

Table 2. Results of livetrapping using various trap types.

Trap Type	Trap Nights	Captures		
		Otter	Beaver	Other
Hancock	102	1	9	2
Bailey	46	1	1	--
Leg hold	146	--	--	2
Box trap	130	--	--	4
Havahart	27	--	--	1
Floating	11	--	--	--
Totals	462	2	10	9

Figure 13. Log piles, frequent otter den sites during fall 1982 and winter 1983 on Lake 4 of the intensive study area, were inundated with water during much of spring 1983 (22 March 1983; River Stage: 17.2 feet).

times appeared to have been in a trap when otters arrived at the site. Seven escapes were experienced with leg hold traps; four by otters and three by beavers. However, to reduce the possibility of injury to captured animals, most No. 3 traps had weak springs.

During the fall waterfowl hunting season, livetrapping efforts were restricted by the owner of private land along the levee where otter activity was concentrated. Also, Hancock livetraps which are suitable for haul out locations along stream banks and other slopes were ineffective on these lakes where haul outs were limited to the log piles or logs projecting out of the water. Livetrapping efforts were further restricted during the fall and spring due to the potential for accidental drowning of trapped animals posed by high and fluctuating levels of the Mississippi River. In addition, during late March and April, trapping was limited due to the possibility of capturing a female soon after parturition.

Radio Telemetry

Surgical implantation of a radio transmitter in river otter M1 was performed on 2 March with Drs. A. Woolf and J. Curl, DVM in attendance. At 1628 hours, the animal was drugged and prepared for surgery. Surgery was completed at 1745 hours and the otter was returned to the indoor section of the holding pen for recovery. The otter was not recovered from anesthesia at 2000 hours; however, at 0700 hours the following day, the otter was in the outdoor section of the pen and recovered. Fresh fish and water were provided; however, only the water appeared to be taken prior to the otter's release. At 1500 hours on 4 March, the otter was placed in the drugging/nest box, transported to Lake 3, and

released near the log pile on the south end of the lake.

The following day, a search of Lakes 1-5 and Johnson Creek yielded no transmitter location; however, several scats were found on the Lake 3 log pile and at the mouth of Johnson Creek. Subsequent ground searches of the entire study area, Cattail Slough, and several nearby areas yielded no sign of the instrumented otter. Aerial searches were conducted and extended from the study area to cover most acquatic environments within a 40 km radius and some areas within an 80 km radius. Helicopter searches were conducted on 18 and 21 April and 1, 13, and 14 June; no transmitter location was made during any search.

On 30 June, a more extensive search conducted by airplane yielded a transmitter location for the otter 4.0 km west of New Boston, Illinois in Louisa County, Iowa, 114 km straightline distance or 138 km by river southwest of the release site (Table 3; Fig. 14). Subsequent aerial monitoring of the otter indicated a pattern of frequent movement in and within 8.2 km of this area. The Lake Odessa area (Fig. 15) contained numerous backwater ponds, lakes, and sloughs and was partially enclosed by a system of levees. The southern two thirds of the area is densely wooded; the northern portion is a national wildlife refuge where much is agricultural land. On 2 July, during a search of the area by canoe, no transmitter location was made and no sign of otter activity was observed. An aerial search on 21 July also yielded no transmitter location. However, a search on 25 July yielded a transmitter location along the previous flight path and only 9.6 km southeast of the last recorded location (Table 3). The 25 July site (Point C) was similar in appearance to the area around Point B, consisting of a complex network of backwater lakes and sloughs partially surrounded by a system of levees.

Table 3. Telemetry data for adult male otter M1 along the Mississippi River in northwestern Illinois and southeastern Iowa, March - December 1983.

Season	Date	Location Point [1]	Location	State/ River Mile	Habitat Description	Distance (km) from Previous Location
Spring	4 March	A	Release site: Lock and Dam 13 area - Swedes Lake (Lake 3)	Illinois 521.3	backwater lake	
Summer	30 June	B	Lake Odessa area (Burris Ditch)	Iowa 435.0	backwater pond and slough	138.0
	25 July	C	Keithsburg area	Illinois 429.2	backwater lakes and sloughs	9.6
Fall	1 September	D	Lampier Ditch	Illinois 446.6	drainage ditch	21.2
	22 September	E	Swan Lake	Illinois 439.7	shallow lake and drainage ditch	7.2
	25 October	F	Lake Odessa area (Yankee Chute)	Iowa 437.2	backwater pond and slough	5.6
	7 November	G	Mississippi River	Iowa 432.1	side channel	7.4
	16 November	H	Lake Odessa area	Iowa 440.3	backwater pond	11.2
	21 November	I	Lake Odessa area (Little Goose Pond)	Iowa 439.0	backwater pond	2.2
Winter	19 December	J	Mississippi River (Otter Island)	Iowa 437.2	side channel and lake	5.0

[1] Transmitter location points from Figs. 14 and 15.

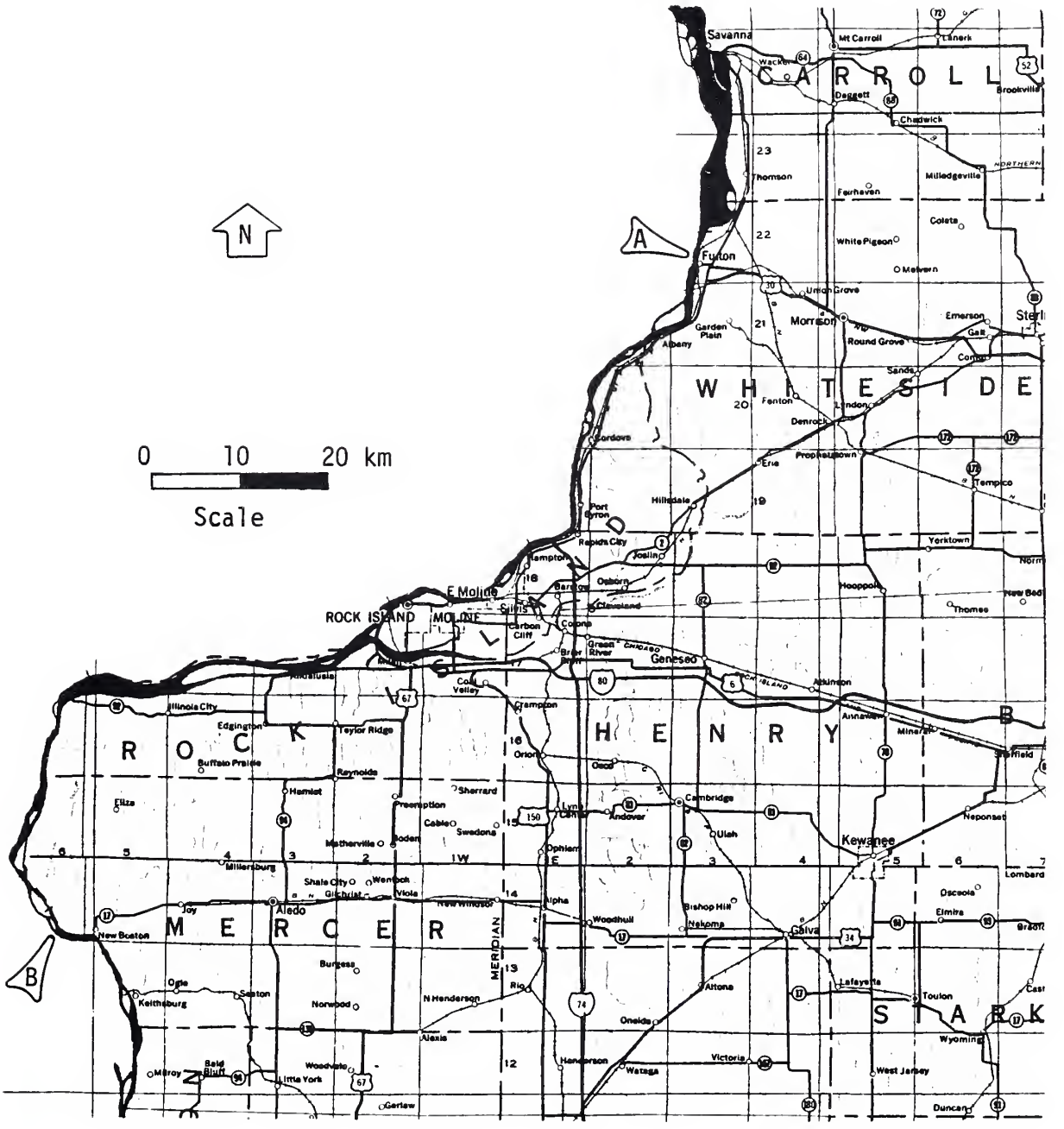


Figure 14. Transmitter location points of adult male otter M1 at release site (A) on 4 March and first transmitter location (B) on 30 June 1983.

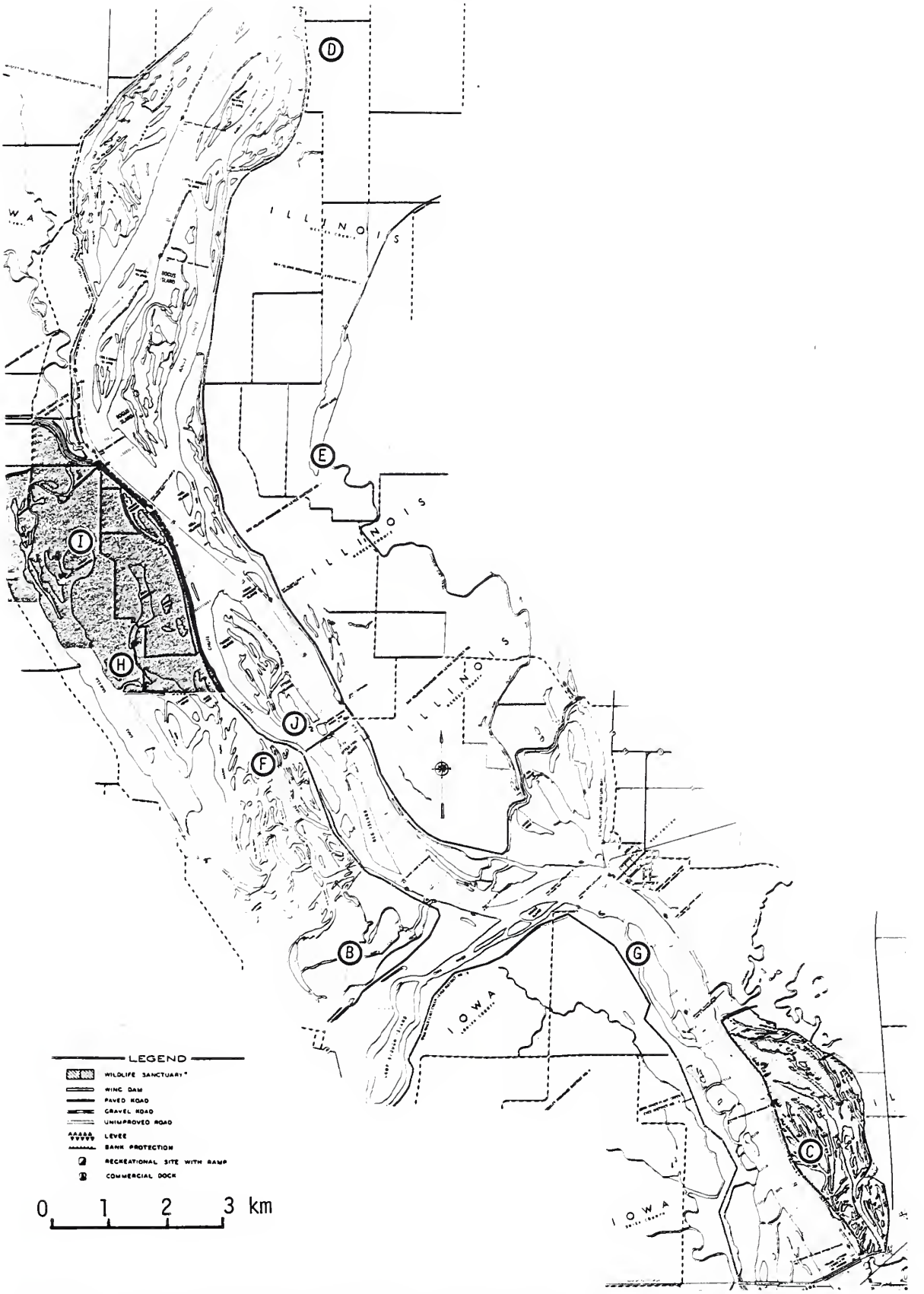


Figure 15. Transmitter location points (B-J) for adult male otter M1 along the Mississippi River, 30 June - 19 December 1983.

Determination of the actual length of stream and lake shore used by otter M1 was not possible due to infrequency of transmitter locations and the complex configuration of areas utilized. However, based on its probable travel routes from 4 March through 1 September, M1 traveled a minimum of 168.8 km during spring and summer (Table 3).

Six transmitter locations of otter M1 were made during fall 1983 (Table 3; Fig. 15). On 1 September, following an unsuccessful aerial search on 25 August, the transmitter was located 21.2 km north of Point C in a small drainage ditch located 0.7 km east of the Mississippi River (Point D). The drainage ditch was surrounded by agricultural land in row crops; riparian vegetation consisted of a narrow border of unidentified grasses and forbs. On 22 September, the transmitter was found 7.2 km south of location D at the outlet of Swan Lake where it joined a drainage ditch (Point E). The lake appeared shallow with emergent vegetation extending over much of the basin. Riparian vegetation was limited to grasses and forbs except at the outlet point which was covered by a small group of trees. On 25 October, a second transmitter location was made in the Lake Odessa area (Point F). The location point was 5.6 km south of Point E along a backwater slough. The transmitter was located 7 November along a wooded side channel of the Mississippi River (Point G) 7.4 km southeast of Point F. Two consecutive transmitter locations (Points H and I) were made in the Lake Odessa area on 16 and 21 November along backwater ponds in the northern portion of the area. During fall, otter M1 traveled a minimum of 33.6 km based on its probable travel routes from 1 September through 21 November (Table 3).

One winter transmitter location was made on 19 December on the

southern tip of Otter Island located northwest of Lock and Dam 17 (Point J, Fig. 15). A small area of open water near the location point probably provided a suitable foraging area. Additional areas of open water were along Burris Ditch of the Lake Odessa area and at the mouth of the Iowa River.

Surgical implantation of a radio transmitter in otter M2 was performed 15 April with Drs. A. Woolf and J. Curl, DVM again in attendance. At 1946 hours, the animal was drugged and prepared for surgery. Surgery was completed at 2148 hours and the otter returned to the indoor section of the holding pen for recovery. At 0700 hours the following day, the otter was in the outdoor section of the pen and fully recovered. The otter was provided fresh fish and water; however, only the water appeared to be taken prior to the otter's release. At 1600 hours, the otter was placed in the drugging/nest box, transported to Lake 5, and released near its probable den site.

Daily monitoring of otter M2 indicated a pattern of frequent movement for a period of 11 days, after which no movement was detected (Table 4). During this time, the otter traveled a total of 6.4 km with a maximum consecutive day movement of 2.4 km (Fig. 16). A variety of den sites (Table 4) were used and selection was apparently based on availability and convenience. Limited data did not establish preference for a given den site or habitat type (Table 4); however, the probable travel route (Fig. 16) traversed a backwater slough (Points A-B), drainage ditches (Points B-C), and a stream (Points C-D).

From 28 April - 13 May, daily transmitter locations were made at the last den site used by otter M2 at Point D (Table 4, Fig. 16) and no sign of activity (fresh scats or tracks) was observed in the area.

Table 4. Telemetry data for male otter M2, 17-28 April 1983.

Date(s)	Location Point[1]	Den Site	Habitat Description
17, 18	A	log pile	backwater lake and slough
19	B	unidentified bank den	backwater slough, drainage ditch
20, 21, 22	C	beaver bank den	backwater slough, drainage ditch, stream
23, 24, 25	D	log pile	backwater slough, stream, pond
26, 27	"	beaver bank den	" "
28	"	woodchuck (Marmota monax) den	" "

[1] Telemetry location points from Fig. 16.

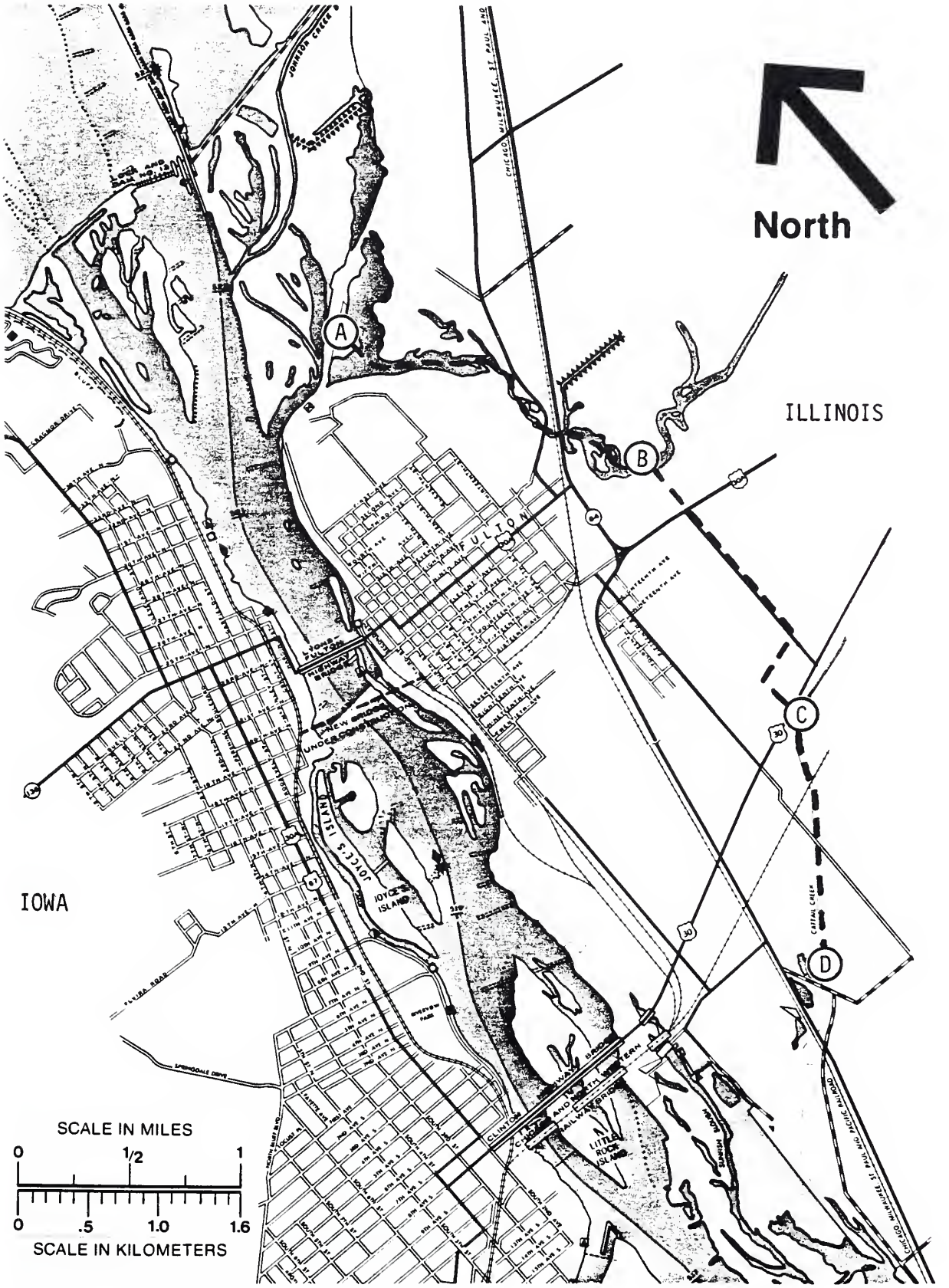


Figure 16. Telemetry location points (A,B,C,D) and route traveled by male otter M2, 16 April - 14 May 1983.

Several attempts to make visual or telemetry contact at times when the otter was most likely to be active (dusk and dawn) indicated no movement outside the den. On 14 May, during an inspection of the interior of the den through an entrance hole, the partially decomposed body of the otter was discovered. The carcass was removed, frozen, and on 19 May, transported to the CWRL. A necropsy performed 20 May indicated the animal was emaciated as evidenced by pronounced atrophy of all muscling, especially those of the pelvic limbs, and a body weight loss of about 28% (Rept. CW83-33 on file at the CWRL). Cause of death was attributed to cachexia which was likely brought about by simple starvation. For unknown reasons, possibly "stress" or a toxic response to capture and surgery, the animal ceased eating. There was no evidence of post-surgical infection or capture myopathy as contributing factors to death.

Critical Habitat

Habitats utilized by river otters along the Mississippi River in northwestern Illinois had several characteristics in common: (1) isolation from the main channel; (2) riparian habitats of extensive woodlands; (3) good water quality; (4) areas of open water in winter; and (5) presence of suitable den sites. Isolation from the main channel of the river by natural topography or man-made levees provided relatively stable water levels compared to the fluctuating levels of the Mississippi River. However, even with such protection, some areas are adversely impacted by water level fluctuations following heavy rainfalls due to local drainage systems and the low floodplain. Although riparian habitats usually consisted of extensive woodlands, areas of aquatic and

marsh vegetation (e.g. American lotus (Nelumbo lutea), cattail, and smartweed) were also common. Water quality was such that it supported good populations of fish and other aquatic life; good water clarity appeared to be of particular importance. In winter, areas of open water which persisted along streams or side channels due to the moving water were preferred habitats. Suitable den sites, some located above high water levels, were readily available and often the result of beaver and/or man's activities.

Evaluation of habitats along the Mississippi River bordering Illinois, southeastern Iowa, and northeastern Missouri identified 13 areas of critical habitat (Table 5, Fig. 17, Appendices 6-18). Generally, major problems associated with each area were water level fluctuations and turbidity attributed to connection with the Mississippi River or limited open water during winter due to insufficient flow through side channels, sloughs, or streams. Therefore, of particular importance were areas which contained aquatic habitats separated by levees or natural topography from the Mississippi River and those which contained open water during winter. Other areas along the Mississippi River contained potential habitat, but, were not listed due to the frequent inavailability of these areas caused by flooding (e.g. Menominee Slough in Jo Daviess County and Potters Marsh in Carroll County). Unless otherwise indicated, critical habitats (Table 5) are owned and managed by a state or federal agency; except, though not indicated, the Marais D'osier Ditch is privately owned.

Food Habits

Food habits of river otters utilizing the study area were based on

Table 5. Critical areas of river otter habitat along that portion of the Mississippi River bordering Illinois, eastern Iowa, and northeastern Missouri and associated problems.

Critical Areas	State and River Miles	Description	Major Problems		
			Water Level Fluctuations	Water Turbidity	Limited Open Water
1. Savanna Proving Grounds	Illinois 550.2-556.7	The area consists of extensive backwater sloughs and narrow channels providing much suitable habitat; restricted access limits trapping pressure and allows relative seclusion, however, ammunition testing may cause disturbances.	X	X	X
2. Green Island Conservation Area	Iowa 546.0-548.0	This area contains habitat in several backwater lakes and sloughs protected within a system of levees. The area is enhanced by unprotected areas of habitat to the northwest and southeast. At least 3 recent reports of otters, including 1 winter observation (Anderson 1982), have come from the area.			X
3. Savanna Bay	Illinois	This complex provides a diverse habitat base including backwater lakes and sloughs, oxbow lakes, and stream habitat. Of particular value may be Rush Creek and the privately owned oxbow lakes south of Apple River and protected by the Mississippi River levee system. The area was the site of several reports of otter signs (Anderson 1982); and, unconfirmed reports of 2 accidental catches of otters by trappers along the oxbow lakes were received. Wooded riparian habitats around several oxbow lakes have been lost; others may be threatened.	X	X	X
Rush Creek	540.0-545.0		X	X	X
Apple River oxbow lakes					X
4. Savanna Slough	Illinois	As with the previous area, this group provides a diverse habitat base. Especially significant is the presence of extensive open water during normal winters along Savanna Slough and protection of wetland habitats by a levee system on the upper unit of Spring Lake. The area has been the site of numerous otter reports and accidental catches by trappers (Anderson 1982) suggesting considerable otter utilization in recent years.	X	X	
Spring Lake	531.7-537.0				
- Upper Unit					X
- Lower Unit			X	X	X
Plum River			X	X	X

Table 5. Continued.

Critical Areas	State and River Miles	Description	Major Problems: Water Level Fluctuations	Major Problems: Water Turbidity	Major Problems: Limited Open Water
5. Lock and Dam 13 area	Illinois	The area provides diverse habitats including unusually deep lakes, backwater sloughs, and stream habitat, portions of which are protected by natural topography, small levees, or Mississippi River levees. Reports of otters (Anderson 1982) suggest considerable use in recent years, particularly since habitat improvements were made as a result of levee construction in 1976. Cattail Slough, which is privately owned, has undergone much channelization and drainage and may be subject to further degradation.	X	X	X
Johnson Creek	521.0-523.0		X	X	
Cattail Slough			X	X	X
6. Meredosia Island	Illinois	Together, these areas provide suitable habitats for otters along the narrow channels of the island and the channelized ditch which drains backwater sloughs and is separated from the river by a levee. An unconfirmed report of otter utilization in winter and other reports from Meredosia Island and at least 2 road-killed otters collected at the junction of the ditch and Route 84, one in November 1972 and the other in April 1983, suggest year-round utilization. Many of the habitats along the ditch have been lost; those remaining may be threatened.	X	X	
Marais D'osier Ditch	510.0-512.5				X
7. Princeton Wildlife Area	Iowa	The Princeton Area supplies limited habitat along a single lake within a levee system, however, additional habitats exist along the sloughs and channels outside the levee system. A specimen of an otter came from Grant's Slough in 1966 (Bowles 1975) and Steamboat Slough was site of winter otter utilization in 1982 (Anderson 1982).			X
Grant's Slough	503.0-506.3		X	X	X
Steamboat Slough			X	X	
8. Lock and Dam 14 area	Illinois	Very limited habitat exists around Lock and Dam 14 and Arsenal Island; but, these must be considered critical as temporary resting sites for otters dispersing along the river corridor. Numerous, privately owned sloughs and lakes south of the Rock River mouth provide more extensive habitat and seclusion.	X	X	X
Arsenal Island	476.7-494.0		X	X	?
Rock River mouth area			X	X	?

Table 5. Continued.

Critical Areas	State and River Miles	Description	Major Problems: Water Level Fluctuations	Major Problems: Water Turbidity	Major Problems: Limited Open Water
9. Lake Odessa area	Iowa 435.0-441.0	The area consists of a complex network of backwater sloughs, ponds, and lakes enclosed within a levee system. An otter was accidentally caught by a commercial fisherman near the area in June 1982. Telemetry data indicate suitable habitat occurs on the area, however, the presence of very limited beaver activity suggests problems may exist. The southern portion of the area receives heavy recreational use. The northern portion is a wildlife refuge; but, some habitats have been lost to agriculture.		X	
10. Keithsburg area	Illinois 428.0-431.0	The area contains a complex network of backwater sloughs and lakes enclosed within a levee system. Winter habitat conditions are unknown; however, the proximity of Edwards River and Pope Creek, the lower portions of which are wooded, may enhance the area for winter utilization. Limited telemetry data suggest the area contains suitable habitat.			?
11. Lock and Dam 18 area	Illinois	This group consists of 3 small areas of backwater lakes and sloughs all protected by the Mississippi River levee system. The northern and southern sites, both privately owned, may be threatened by future drainage. The Lock and Dam 18 site is part of a wildlife refuge; proximity to the Henderson River Diversion Ditch may enhance the site for winter utilization.			?
sloughs and lakes (names unknown)	405.0-414.2				?
12. Quincy Bay area	Illinois 328.0-332.0	The area includes backwater sloughs and lakes separated from the Mississippi River by a relatively wide (0.4-0.8 km) stretch of woodland. The area may lack somewhat in seclusion due to the proximity of Quincy.	X	X	?
13. Dogfish Slough	Missouri	The area consists of privately owned backwater sloughs and ponds enclosed within a levee system. The area is included in the Kings Lake Drainage District and may be subject to future drainage. Partially protected habitats along the Illinois side of the river enhance the site for otter utilization.			?
Ligon Slough	246.2-250.0				?
Birch Slough					?

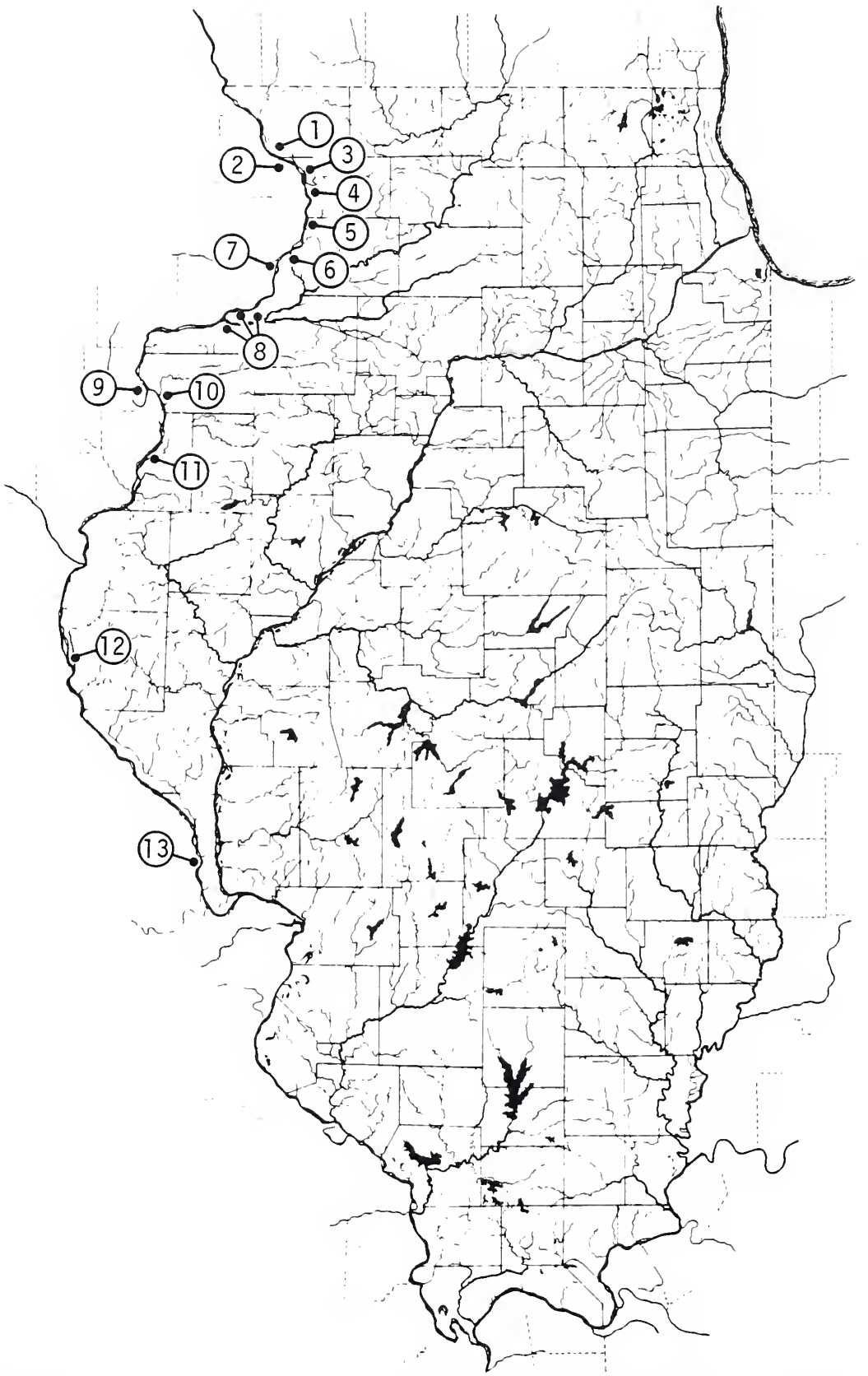


Figure 17. Location of 13 areas of critical river otter habitat along the Mississippi River in Illinois, southeastern Iowa, and northeastern Missouri.

analysis of 765 scats collected from the area between October 1982 and June 1983 (Table 6). Fish were the dominant food item each season and occurred in 98% of scats collected. At least 8 families of fish were represented with Centrarchidae (sunfishes), Cyprinidae (minnows and carps), Clupeidae (herrings), and Percichthyidae (temperate basses) occurring in 49%, 41%, 36%, and 16% of all scats, respectively. Next in importance were amphibians (frogs) and crustaceans (crayfish), each occurred in 9% of the scats. Insects and birds were identified in 3% and 2% of all scats, respectively. Trace amounts of otter hair found in many scats probably originated from grooming.

Notable differences in frequency of occurrence of the different food items were evident when the data were analyzed per location (Table 7). Fish remained the dominant food item at all locations; however, at Lake 1, crustaceans were an important food item occurring in 35% of the scats. And, on Johnson Creek, 36% of the scats contained remains of amphibians. Centrarchidae, Cyprinidae, Clupeidae, and Percichthyidae were the dominant fish at all locations; however, order of importance varied depending on location. Analysis of 158 additional otter scats from the study area and other areas along the Mississippi River indicated similar variation depending on collection site (Appendix 19).

Based on limited fish survey data (Appendix 20), otters generally appeared to take fish in proportion to availability. Direct correlation between abundance of specific families from a given site and frequency of occurrence in scats from the same site was not evident. However, Centrarchidae, Clupeidae, Cyprinidae, and Percichthyidae were most abundant and accounted for 30%, 27%, 17%, and 11% of the fish collected from the study area, respectively. These surveys also indicated species

Table 6. Number of occurrences and frequency of occurrence to nearest percent per season of food items in 765 otter scats collected from the intensive study area north of Fulton, Illinois; October - June 1983.

Food Item	Fall(Oct-Nov)	Winter(Dec-Feb)	Spring(Mar-May)	Summer(Jun)	Total
Sample size:	154	318	277	16	765
FISH	154(100)	317(99)	269(97)	11(69)	751(98)
Centrarchidae (Sunfishes)	125(81)	156(49)	86(31)	5(31)	372(49)
Cyprinidae (Minnows and carps)	26(17)	140(44)	145(52)	- -	311(41)
Clupeidae (Herrings)	14(9)	119(37)	136(49)	6(38)	275(36)
Percichthyidae (Temperate basses)	8(5)	40(13)	73(26)	- -	121(16)
Esocidae (Pikes)	3(2)	3(1)	12(4)	1(6)	19(2)
Percidae (Darters and perches)	2(1)	3(1)	8(3)	- -	13(2)
Amiidae (Bowfins)	2(1)	1(1)	8(3)	- -	11(1)
Catostomidae (Suckers)	- -	2(1)	- -	- -	2(1)
Unidentified fish	7(5)	8(3)	6(2)	2(13)	23(3)
AMPHIBIANS					
Frog (Rana spp.)	12(8)	47(15)	8(3)	1(6)	68(9)
CRUSTACEANS					
Crayfish (Cambarus spp.)	8(5)	18(6)	32(12)	8(50)	66(9)
INSECTS					
Dragonfly nymph (Odonata)	10(6)	8(3)	6(2)	- -	24(3)
BIRDS (Unidentified)	3(2)	1(1)	11(4)	2(13)	17(2)

Table 7. Number of occurrences and frequency of occurrence to nearest percent per location of food items in 765 otter scats collected from the intensive study area north of Fulton, Illinois; October 1982 - June 1983.

Food Item / Sample size:	Lake 1 52	Lake 2 27	Lake 3 204	Lake 4 270	Lake 5 78	Johnson Creek 107	Mississippi River 27
FISH	46(88)	27(100)	201(99)	269(99)	78(100)	103(96)	27(100)
Centrarchidae (Sunfishes)	17(33)	11(41)	95(47)	184(68)	20(26)	40(37)	5(19)
Cyprinidae (Minnows and carps)	14(27)	12(44)	83(41)	73(27)	40(51)	73(68)	16(59)
Clupeidae (Herrings)	14(27)	5(19)	108(53)	64(24)	45(58)	31(29)	8(30)
Percichthyidae (Temperate basses)	7(13)	7(26)	50(25)	24(9)	9(12)	17(16)	7(26)
Esocidae (Pikes)	2(4)	1(4)	4(2)	8(3)	4(5)	- -	- -
Percidae (Darters and perches)	1(2)	2(7)	5(2)	4(1)	1(1)	- -	- -
Amiidae (Bowfins)	3(6)	1(4)	3(1)	3(1)	- -	1(1)	- -
Catostomidae (Suckers)	- -	1(4)	1(1)	- -	- -	- -	- -
Unidentified fish	4(8)	4(15)	5(2)	4(1)	2(3)	4(4)	- -
AMPHIBIANS Frog (Rana spp.)	2(4)	- -	10(5)	13(5)	4(5)	38(36)	1(4)
CRUSTACEANS Crayfish (Cambarus spp.)	18(35)	4(15)	20(10)	9(3)	8(10)	7(7)	- -
INSECTS Dragonfly nymph (Odonata)	5(10)	1(4)	2(1)	14(5)	1(1)	1(1)	- -
BIRDS (Unidentified)	2(4)	- -	5(2)	6(2)	3(4)	1(1)	- -

of fish which were no doubt principal prey of otters, specifically: bluegill (Lepomis macrochirus), gizzard shad (Dorosoma cepedianum), carp (Cyprinus carpio), and white bass (Morone chrysops).

Mortality

Since 1981, 9 river otters (7 males, 2 females) have been necropsied at the CWRL (Appendix 21). Causes of death suggested important mortality factors throughout the state and included 4 roadkills, 3 accidental catches by trappers, and 2 catches by commercial fishermen. Accidental catches by trappers were made in "cubby sets" for raccoons (Procyon lotor) with a #220 conibear trap and baited with dead fish. Heavy metal analysis of 4 specimens (Appendix 22) indicated high concentrations of nickel in a juvenile otter from Pope County; the liver and a kidney yielded 22.86 and 6.32 ppm (parts per million) dry weight of nickel, respectively. Other elemental levels were within expected ranges.

DISCUSSION

Seasonal Habitat Utilization and Characterization

Fall

The study area and surroundings had a history of river otter utilization during this season as evidenced by past reports (Anderson 1982). The first report in recent times occurred about 1950 when an otter was sighted near the point where Lake 3 connects with the Mississippi River; however, over the next 30 years, otters were rarely seen in the area (C. Jacobs, landowner, pers. commun.). In 1980, following completion of the levee, 2 otters were sighted on Lake 3 and believed to den in a log pile along the lake shore. Six otters were observed in October 1981, 2 km up Cattail Slough; and in November, 5 otters, probably of the same group, were noted on Lake 4. On 27-28 November, fresh otter scats were collected from haul outs located on log piles along Lake 4.

Since 1980, use of the area appeared to increase in response to habitat improvements resulting from levee construction; specifically, deposition of log piles along lake shores and deepening of Lakes 3-5 through dredging. These improvements combined with isolation from, yet proximity to, waters of the Mississippi River enhanced the suitability of the area. As indicated, log piles were important components of the habitat as evidenced by haul out and probable den site locations. Radio telemetry work in Idaho by Melquist et al. (1981) indicated instrumented otters extensively utilized log jams both for den sites and foraging areas. Further, Melquist et al. (1981) noted habitat utilization was almost entirely determined by foraging and resting areas as otters selected suitable den sites near foraging areas. Presumably, deepening

of the lakes resulted in a larger, more diverse fish population through an increase in lake volume and habitat diversity thereby providing a larger prey base for otters. Proximity to the river allowed a natural restocking of fish populations in these lakes during high water stages and provided a suitable dispersal route for otters.

Another notable characteristic of preferred otter habitat was isolation from the main channel of the Mississippi River which resulted in less severe fluctuations in water levels and an improvement in water clarity. During October and November, the low levels of otter activity on Lakes 1 and 2, Johnson Creek, and the Mississippi River border was probably due to the high water levels of the river (Fig. 6). For comparison, flood stage is 16.0 ft and average river stage for 1982 was 9.7 ft. Such high water caused a noticeable and negative impact on water clarity in these areas. Further, when the river stage exceeded about 11.5 ft, as on 29 October, much of the area around Lakes 1-3, Johnson Creek, and the Mississippi River border was inundated with water restricting or eliminating suitable den sites.

Winter

During winter, the presence of open water appeared to have the greatest influence on river otter habitat selection. River stages, a major factor influencing fall habitat selection, fell to 8.9 ft on 13 December and stabilized at or below average stages through most of late December and February (Rock Island District, U.S. Army Corps of Engineers, unpubl. data). As water levels fell, otters again utilized previously unused portions of the study area. A noticeable improvement in water clarity associated with stabilization of water levels, the winter

snow cover, and the absence of barge traffic was noted on these areas and may have influenced habitat use. However, as ambient temperatures fell in January and February, utilization of open water as foraging areas became increasingly apparent. Otters will often travel great distances to reach areas of open water (Erlinge 1967, Park 1971, Bottorff et al. 1976, Goodman 1981). Melquist and Hornocker (1983) indicated unobstructed portions of streams were preferred habitat during winter because the moving water remained open. The total ice coverage of Lake 4 and the presence of open water along Johnson Creek and on Lake 3 appeared to cause the simultaneous decline of otter activity on Lake 4 and notable increases on Lake 3 and Johnson Creek during January.

During winter 1982, otter activity was restricted to Lakes 1 and 2 and lower Johnson Creek and was believed to be due to the presence of open water on Johnson Creek and the lack of it elsewhere. Although Johnson Creek remained open through much of winter 1983, it appeared to be preferred habitat only when other areas became ice covered as they did during January. Johnson Creek is a rather sterile stream having primarily a sand/silt bottom and water depths of about 0.25 m along all but the lower 1.0 km. During 1982 and 1983, otter utilization reflected this in locations of haul outs along only the lower stretch of the creek.

Spring

Habitat selection within the study area during spring appeared once again to be influenced by Mississippi River stage and also food availability. During spring, river stages were high and crested at 18.6 ft on 19 March (Fig. 6). From 12 - 28 March and 18 April - 5 May, when

levels remained at or above 14.0 ft, water from the Mississippi River inundated the entire study area within the levee system with exception of Lock and Dam 13 facilities and entrance road and a portion of the small levee near Den Site 1 (Fig. 10). Such high water eliminated most suitable den sites within the levee system, including the log piles along Lakes 3 and 4; however, during this period, the group of 2 otters continued to utilize Den Site 1 which was slightly above water level. The group of 3 otters continued to utilize Den Site 2 (Fig. 10) until 1 April when local rainfall caused water levels in Lake 5, located outside the levee system, to rise. The otters then moved to Den Site 3 (Fig. 10) which normally was situated well above normal water level but now was partially in water. So, despite high river stages during March, river otter utilization of the study area actually increased to its highest level and appeared in response to food availability as indicated by haul out locations. A large number of fish, especially carp, was observed passing through shallow, inundated areas adjoining the lakes and creek. Apparently, otters were attracted by an abundant supply of fish and selected den sites in proximity to foraging areas. In Idaho, Melquist and Hornocker (1983) noted a similar concentration of otters around areas where fish were spawning. Further, it was indicated that although food had the greatest influence on habitat use, the habitat must provide adequate shelter if it is to be extensively used by otters (Melquist and Hornocker 1983). The increase in utilization may also have been due in part to inundation of occupied habitats outside the study area which forced additional otters onto the area. During April and May, as water levels dropped and the shallow inundated areas disappeared, utilization declined apparently in response to the dwindling

supply of fish.

Summer

Limited field survey data revealed no apparent cause for the decline in river otter utilization of study area habitats. However, at least some otters probably moved to sites nearby such as marshes and backwater sloughs which were unsuitable during high river stages of fall and spring or during ice coverage in winter. Melquist and Hornocker (1983) noted mudflats, marshes, and backwater sloughs were important summer habitats, especially to family groups.

Radio Telemetry

Telemetry data for otter M1 supported findings which indicated backwater lakes, ponds, and sloughs were preferred habitats along the Mississippi River. Further, areas protected by a levee system (e.g. the Lake Odessa and Keithsburg areas) or natural topography from water level fluctuations and turbidity common to the Mississippi River and its tributaries were utilized most frequently and might provide habitats of significantly higher quality than unprotected area. The preference for open water during winter indicated by field surveys was also supported by a single transmitter location for otter M1 in December adjacent to open water.

Although distances traveled by otter M1, an adult male, may have included single excursions into areas, these activities were considered a rough estimate of seasonal home ranges. Such movements, though extensive, were not unusual for a male otter. Though data were lacking for adult male otters, Melquist and Hornocker (1983) indicated one yearling male otter used 81 km of stream as spring and summer home range;

single excursions into areas increased the total area visited to 135 km compared to the 168.8 km traveled by otter M1. However, summer home range of 7 instrumented otters averaged only 34 km based on length of stream and shoreline used more than once (Melquist and Hornocker 1983); summer home range of 3 yearling males in this group averaged 43 km. During fall, a yearling male used 34 km of stream as home range (Melquist and Hornocker 1983); this compared closely with the 33.6 km traveled by otter M1. Infrequency of monitoring and complexity of backwater habitats made such comparisons questionable as actual length of shoreline within a given length of the Mississippi River varies considerably. However, swamps and backwater sloughs adjacent to streams and rivers in Idaho noted by Melquist and Hornocker (1983) suggested habitat composition was not completely unlike those along the Mississippi River.

Failure to locate otter M1 during 2 aerial searches was believed due to transmitter signal obstruction rather than extensive movements away from the Mississippi River, as subsequent transmitter locations were never far from previous locations. Obstructions such as soil, rocks, and vegetation decreased range of the transmitter signal. Use of steel drainage culverts as resting sites by the otter may have further decreased signal range.

Limited telemetry data for otter M2 suggested backwater sloughs, drainage ditches, and streams adjacent to the Mississippi River may have provided important travel routes when moving between sites of suitable habitat. Such routes would provide greater seclusion, especially when used to travel around towns and cities as was done by M2. Further, drainage ditches may have provided suitable habitat when associated with backwater lakes, ponds, or sloughs. Similar use of feeder streams as

routes to small ponds and reservoirs was noted by Melquist and Hornocker (1983).

Critical Habitats and the Otter Population

Areas of critical river otter habitat did not appear evenly distributed along the Mississippi River bordering Illinois (Fig. 17). Seven critical habitats were located along the 157 km stretch of the river north of the Quad Cities (Rock Island and Moline, Illinois and Davenport and Bettendorf, Iowa); but, only 4 locations were along an equivalent length of the river to the south. Only 2 additional areas were along the remaining 619 km of the river to its confluence with the Ohio River. Distribution of river otters in Illinois (Fig. 1) reflected this. As indicated by previous study (Anderson 1982), there appears to be unoccupied habitats available along the Mississippi River south of the Quad Cities. The hypothesis that the Quad Cities created a dispersal barrier unlike any other on the Mississippi River (Anderson 1982) may be valid as indicated by distribution of very limited areas of critical habitat, probably only temporary resting sites, along this stretch of the river (Appendix 13). Movement of otter M1, an adult male, through or around the cities suggested at least some continuity of otter populations to the north and south of them. However, male otters tend to travel much more extensively than females (Erlinge 1967, Melquist and Hornocker 1983), and so, might have been more likely to leave habitats to the north and pass through the Quad Cities. Necropsy data (Appendix 21) may have reflected the increased chance for males, particularly adult males, to reach habitats south of the Quad Cities as the only 2 specimens collected along this portion of the river in recent years were

large, obviously "aged", adult males. Therefore, insufficient numbers of otters, especially females, may pass through or around such a barrier for a viable population to become established to the south.

Food Habits

Toweill and Tabor (1982) cited results of food habits studies on river otters from many portions of their range in North America. And, as indicated in this study, the bulk of the river otter's diet was composed of fish; crustaceans, amphibians, insects, birds, and mammals comprise lesser portions (Toweill and Tabor 1982). Further, Toweill and Tabor (1982) suggested river otters take fish in direct proportion to availability. Comparison of food habits and fish survey data from the present study agreed with this finding. Toweill and Tabor (1982) also noted abundant, slow swimming fish species such as carp (Cyprinidae) would be selected more often than their abundance would indicate. This may explain the apparent selection of Cyprinidae over Clupeidae by otters on the study area though Clupeidae were in greater abundance. Toweill and Tabor (1982) indicated sunfishes and perches that are often abundant and found in large schools would be important prey items. Thus, the occurrence of Centrarchidae, Clupeidae, and Percichthyidae in scats from the study area was expected as representatives of these families were abundant and occurred in schools.

Mortality

Necropsy data indicated not only probable major mortality factors but also the wide ranging habits of otters, particularly males, throughout Illinois. Although most otter deaths are probably not detected,

man-related activities were responsible for each of 9 mortalities noted. Melquist and Hornocker (1983) suggested many deaths were probably due to road-kills associated with roads and railroads that parallel or cross streams. This is no doubt an important factor in Illinois as indicated by necropsy data. The importance of accidental catches by trappers and commercial fishermen as mortality factors indicates areas of concern when future management decisions are made.

Impacts of Various Resource uses

The Mississippi River is a major multi-purpose water resource providing commercial transportation, water supplies, and recreation; in addition, it plays a vital role in providing habitat for aquatic and terrestrial wildlife (Upper Mississippi River Basin Commission - UMRBC 1982). During this study, much information was collected regarding the potential impact the various resource uses might have on the otter population.

Commercial transportation (barge traffic) is known to increase the amount of suspended solids and sediments carried by the Mississippi River (UMRBC 1982). The poor water clarity and fluctuating water levels along the river border of the study area and backwaters directly connected with the river appeared causes for the limited utilization by otters during fall and spring. During winter, an improvement in water clarity associated with snow coverage and the absence of barge traffic was accompanied by an increase in otter utilization suggesting water clarity and open water influenced habitat use.

Impacts of recreational activities were also noted during the study. Moderate amounts of sport fishing had no apparent influence on river

otter utilization of study area habitats. Log piles along Lake 4 were frequented for fishing while simultaneously used as den sites. Limited waterfowl hunting also seemed to have negligible impact. The nocturnal habits of otters resulted in few occasions for human contact thus minimizing impacts of most recreational activities. However, numerous otter sightings have been reported by fishermen and waterfowl hunters. Melquist and Hornocker (1983) indicated several otters were wounded or killed by gun-fire in Idaho despite receiving total protection. Public awareness of the protected status of river otters in Illinois should limit such occurrences. Furbearer trapping has the potential for greatest impact on the otter population; it appears that the use of "cubby sets" for raccoons, poses a serious threat as suggested by necropsy data. Also, frequent use of beaver bank dens by otters increases the likelihood of capture in beaver trap sets.

Commercial fishing on Lakes 3-5 appeared to have no influence on otter habitat selection. However, necropsy data indicated several losses to commercial fishing nets in recent years. Several times during the study, gill nets were used on Lakes 4 and 5; these nets occasionally stretched across the entire width of the southwest and north ends of Lake 4 but did not appear to affect otter activity.

Impacts of Fluctuating Water Levels

As previously indicated, water level fluctuations appeared to have a significant influence on habitat and den selection. Most studies indicate that the peak time of parturition in river otters is in March and April (Toweill and Tabor 1982). Therefore, during these months, rapid rises in water levels could potentially flood otter den sites

drowning young otters. Based on river stage records for the Clinton, Iowa station from 1933-1983 (Rock Island District, U.S. Army Corps of Engineers, unpubl. data), peak water levels on the Mississippi River occur in April and average 11.8 ft; May, June, and March are next with average river stages of 10.6, 9.4, and 8.4 ft, respectively. So, peak parturition probably coincides with the month of highest average river stage. Maximum river stage for the same station and time period (Appendix 23) indicated years during which severest flooding occurred. As previously mentioned, when river stage exceeded about 11.5 ft much of the study area was inundated due to the low floodplain although flood stage is considered 16.0 ft. Therefore, the maximum river stage has exceeded flood stage during March and/or April in 15 out of the past 51 years, including 10 out of the last 19 years (Appendix 23). Such high levels could have significantly impacted recruitment and might represent a potential limiting factor on the otter population.

Conclusions

The river otter is currently listed as a "threatened" species in Illinois; however, with its limited population size and geographic range as well as the continued loss and degradation of habitat, listing as "endangered" seems warranted. However, since its listing as "threatened", there is no evidence to indicate that populations have either increased or declined. The limited population size and range was previously documented (Anderson 1982). Although there is much, "apparently" suitable habitat preserved within the Mississippi River levee system in Illinois, much is only seasonally available due to inundation by flood waters in spring and complete ice coverage in winter. In addition, these habitats

are threatened through loss of aquatic habitats to sedimentation of backwater areas (UMRBC 1982). Loss of habitat through silt deposition and its deleterious effect on fish and waterfowl have already occurred and been documented along the Illinois River (Mills et al. 1966). The now shallow, platter shaped lakes on the Illinois and Mississippi rivers provide little or no chance for winter otter utilization as complete ice coverage effectively seals such lakes. Projected increases in barge traffic and a corresponding increase in suspended sediment on the Mississippi River may accelerate the loss of habitats on this river (UMRBC 1982).

Outside the levee system, few suitable habitats remain as channelization has changed many productive, meandering streams into unproductive, channelized ditches (Lopinot 1972). In 1972, it was determined that there were over 13,000 km of channelized streams in Illinois with over 1600 km of these occurring in counties bordering the Mississippi River (Lopinot 1972).

MANAGEMENT AND RESEARCH RECOMMENDATIONS

Whether the river otter survives as a part of the Illinois fauna along the Mississippi River will depend on public interest and the implementation of sound management techniques by the IDOC, U.S. Fish and Wildlife Service, and Army Corps of Engineers. We believe a "recovery plan" is necessary to maintain the otter as a viable part of the fauna of Illinois. The river otter attracts a great deal of public interest because of scarcity and appeal as a "wilderness" species; and, the IDOC has displayed strong interest in research. The following is offered in the interest of future management decisions and in the development of a recovery plan:

(1) Habitat Management

As indicated, there are areas of critical (suitable) habitat along the Mississippi River; special efforts should be made to preserve, protect, and enhance these areas for river otters. Current ownership and management of most areas of existing habitat by governmental agencies greatly increases the possibilities and responsibilities for sound management. During land use planning, particular attention should be given to maintenance of riparian habitats so that the integrity of these critical areas is preserved.

Efforts should be made to enhance potential otter habitats. The study area should serve as an example of what ought be accomplished when wildlife habitat requirements are considered during flood control projects. Specifically, the deposition of trees removed during levee construction into log piles provided ideal den sites for furbearers including river otters. Further, when placed in shallow water along the edge of lakes and sloughs these piles served as fish attractors and provided

foraging sites for otters. Construction of log piles above normal and high water levels is recommended in areas of critical habitat where suitable den sites are limited. Dredging of adjacent bodies of water to obtain material for levee construction may be an enhancement through increase in diversity in aquatic habitats; however, careful planning is needed to minimize destruction of riparian habitats. Construction of levees around even small areas of potential habitat would improve sites for otter utilization and permit management of water levels.

Identification of several areas of critical habitat under private ownership (i.e. Site 3, Apple River oxbow lakes; Site 5, Cattail Slough; and Site 6, Marais D'osier Ditch) suggests need for cooperation between the IDOC and landowners to preserve existing riparian habitats. Acquisition of such sites to insure preservation should be considered.

(2) Species Management

A suitable monitoring system for the river otter as previously outlined (Anderson 1982) should be established to permit periodic assessment of its status. There are areas with suitable, but essentially unoccupied, otter habitat along the Mississippi River south of the Quad Cities (Anderson 1982). Provided these habitats do not deteriorate where they are no longer suitable, otters may repopulate these areas. However, because of very limited patches of suitable habitat along the river through the Quad Cities and the potential dispersal barrier created by this situation, natural repopulation may not occur.

Release of otters, particularly adult females, might be considered at some future date if natural repopulation fails to occur. The Lake Odessa and Keithsburg areas, both parts of the National Wildlife Refuge System (Louisa and Keithsburg divisions), could serve as release sites

and provide core areas from which reintroduced otters could disperse. Incorporation of a radio telemetry project with any reintroduction program would be beneficial providing additional habitat utilization information and allowing monitoring of reintroduction success.

(3) Regulations and Legislation

Changes in trapping regulations (Anderson 1982) should be considered, particularly, establishment of "no trapping areas" on known otter wintering areas; especially important are the Savanna Slough and Lock and Dam 13 areas. River otters are especially susceptible to trapping on these areas where activities are confined to a relatively small area. Banning of conibear land sets such as the "cubby sets" for raccoons should be considered for areas along the Mississippi River. Alternatively, requiring leg hold traps (less than #3 size) in place of the conibears would permit capture of most raccoons while allowing escape of the larger otters or release of those captured.

(4) Information and Education

The IDOC should continue to keep the public informed of activities related to the river otter through press releases. Several articles describing activities in recent years have been beneficial in increasing public awareness. Films, slide programs, and oral presentations should be developed to inform public groups of the river otter's status. Because of its appeal as a "wilderness" species, the river otter would be ideally suited for inclusion in materials prepared for promotion of the recently instituted Illinois Non-game income tax check-off program.

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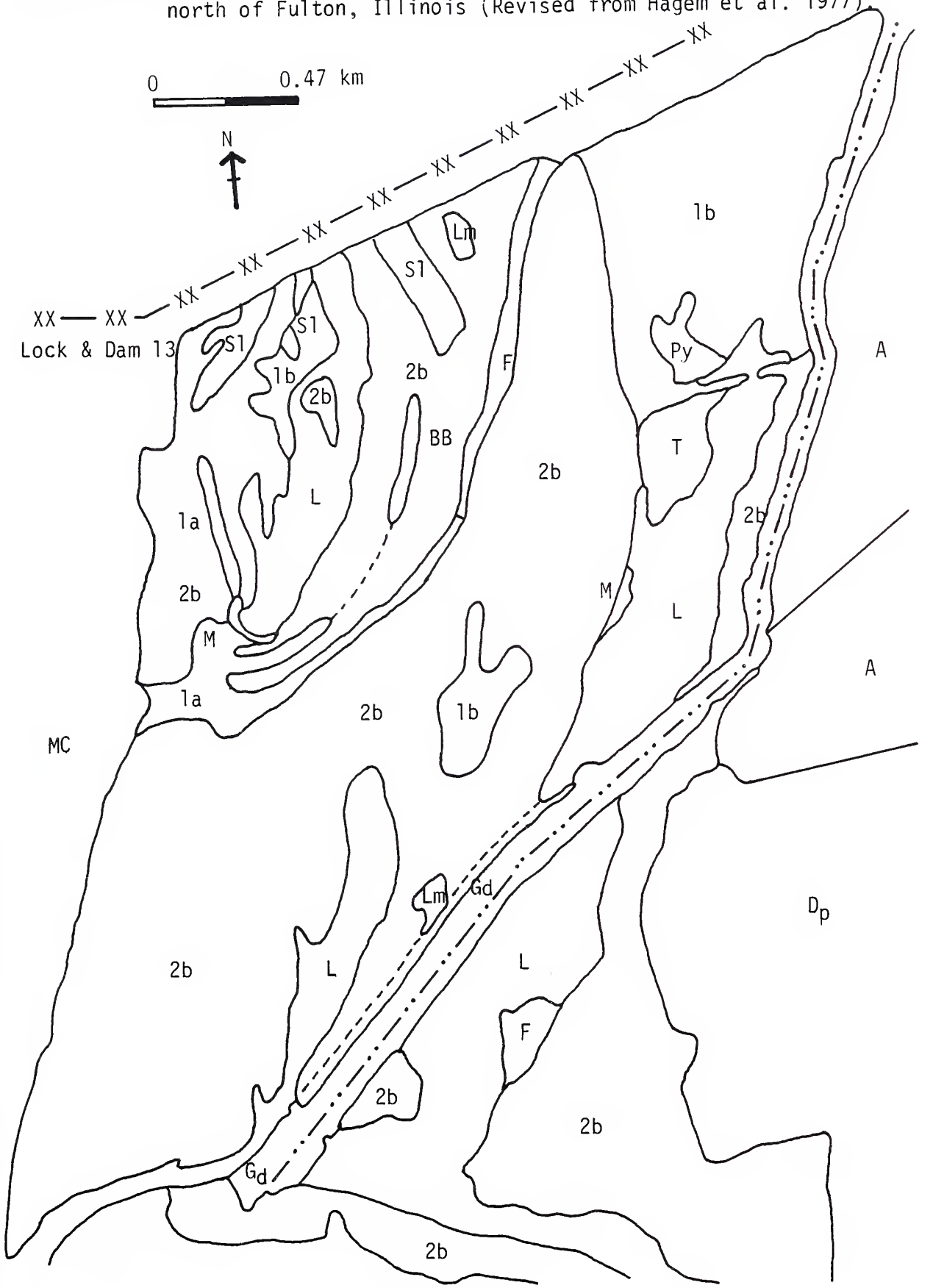
Appendix 1. Classification scheme used in cover type mapping of areas utilized by river otters along the Mississippi River in northwestern Illinois and southeastern Iowa (From Hagen et al. 1977).

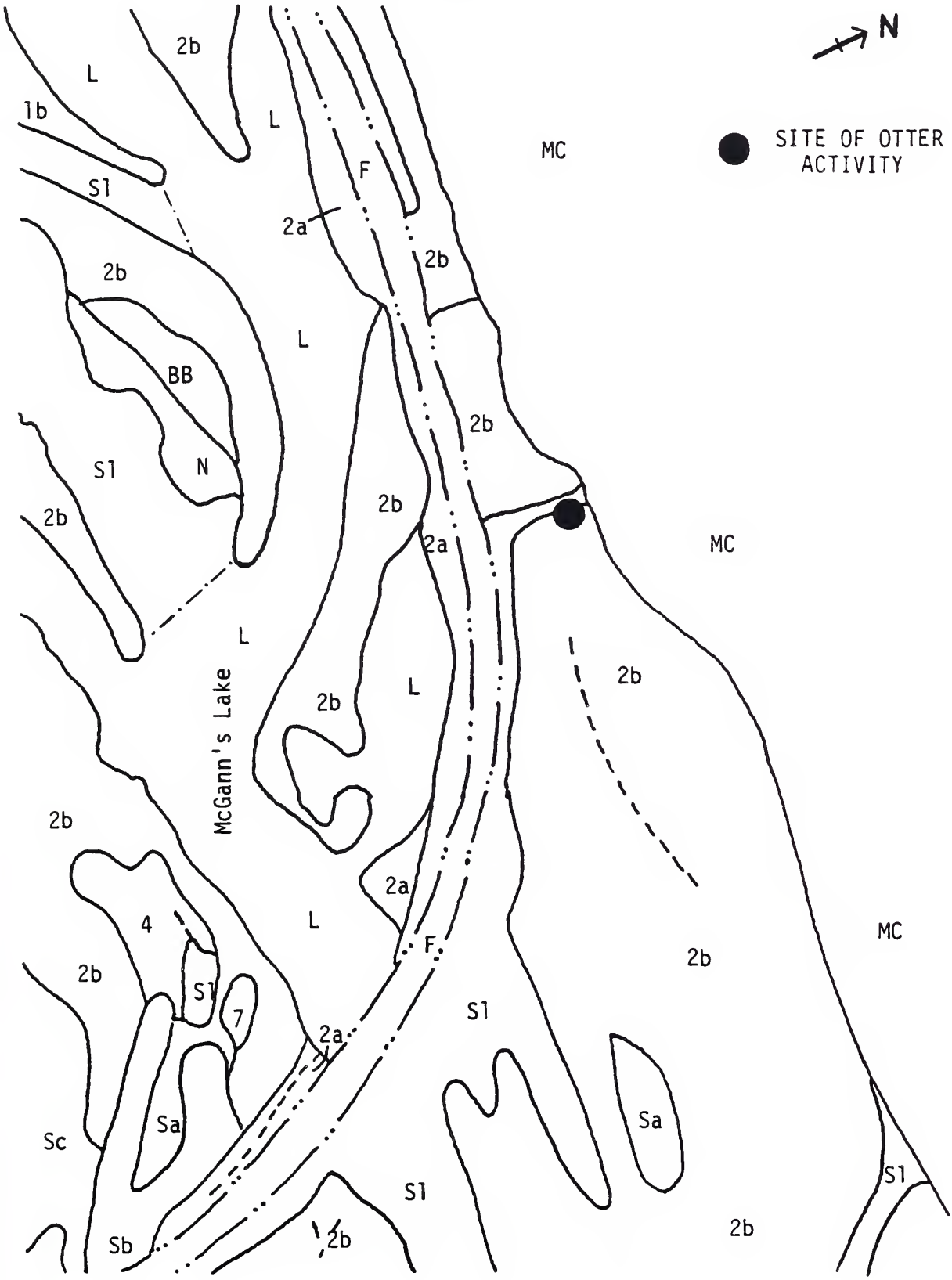
Class	Minimum Area Classified	Symbol	Type Description
Open Water	1.0 acre	MC	Main Channel - the 9-foot navigation channel and all open water between it and the river bank or the first island or the first bed of aquatic vegetation.
		SCh	Side channel - all free flowing bodies of water separated from the main channel by an island and which are not obstructed by a wing dam or closing dam and which appear to be capable of supporting commercial navigation.
		L	Lake - a non-linear body of water greater than or equal to 10 acres in size and having little or no current entering it from the river.
		P	Pond - a natural body of water less than 10 acres in size separated by land from the river, and less than 1.5 times long as it is wide (non-linear).
		P_d	Industrial pond such as a tailing pond, sewage treatment pond or fish rearing pond
		P_f	Farm pond.
		SS	Sidestream (classification used for acreage summaries only).
		Sl	All remaining water bodies whether flowing or stagnant and usually linear in nature.
		— — —	Narrow sloughs not wide enough to permit delineation on overlay.
		-·-·——·-·-	Side stream
		——·——·-·	Type line dividing two open water bodies.
Sand and Mud	1.0 acre	S	Water-deposited sand.
		M	Water-deposited mud (sometimes includes wet sand which was difficult to distinguish from mud).
Aquatic and Marsh Vegetation	1.0 acre	Sb	Submergent aquatics
		7	Submergent aquatics and duckweed; Ceratophyllum demersum (coontail) is often the dominant submergent species in this type.
		Po	Floating-leaf pondweeds such as Potamogeton americanus; this type was rarely encountered.
		Lm	Lemnaceae (duckweeds) is characteristic of small, stagnant water bodies. In some cases, submergents may have been present but not discernible.
		Ny	Nymphaea (water lily) was rarely encountered.
		N	Nelumbo lutea (American lotus)
		6	Nelumbo lutea and duckweed
		Sa	Sagittaria spp. - primarily latifolia (duck potato).
		Sp	Sparganium spp. - (bur reeds) were uncommon.
		Sc	Scirpus fluviatilis (river bulrush).
		J	Jusslaea sp. (water primrose) - very localized occurrence.
		Py	Polygonum spp. (smartweeds) - a diverse class including emergents and marsh species, annuals and perennials.
		T	Typha latifolia and T. angustifolia.
		E	Eragrostis spp. (love grasses).
Terrestrial Herbaceous Vegetation	1.0 acre	G	Mixed grasses (other than Le Ph or E). Not a major type; some overlaps into the marsh category.
		F	Forbs - mixed broadleaf weed species mostly of Eurasian origins; the most common genera include Amaranthus, Zanthium and Ambrosia. Some overlap into the marsh category.
		Le	Leersia oryzoides (rice cut-grass) considerable overlap into marsh category.
		Ph	Phalaris arundinacea (reed canary grass).
		C	Wild cucumber (Echinocystis lobata)

Class	Minimum Area Classified	Symbol	Type Description
Woody Vegetation	2.0 acres	1a	Cottonwood and/or tree willow with an average height of less than 20 feet.
		1b	Cottonwood and/or tree willow with an average height of greater than 20 feet.
		2a	Mixed lowland hardwoods with an average height of less than 20 feet.
		2b	Mixed lowland hardwoods with an average height of greater than 20 feet.
		Px	Plantation - a stand of planted trees as opposed to one resulting from natural regeneration.
		BB	Buttonbrush (Cephalanthus occidentalis)
		4	Shrub species and/or woody vines which normally do not attain a height greater than 20 feet.
Land Use	2.0 acres	A	Agriculture - all areas appearing to have been tilled or pastured within the past year; includes areas tilled and planted for wildlife foods. Abandoned fields are usually typed F.
		G_d	Developed grass - all areas such as most levees which are covered largely by grasses and which are mowed at least once per year; also includes lawns over two acres in size.
		O_p	Developed parks - includes campgrounds, picnic areas, golf courses, and other outdoor recreation areas with developed user facilities. Inclusions such as parking lots or open lawns over two acres in size would be typed as D or G, respectively.
		O	Developed - all areas which are essentially nonvegetated due to man's activities (excluding plowed croplands).
		R	Residential - typically comprised of streets, houses, lawns, shrubs and trees.
Dredged Materials	0.5 acre	Dm-	Associated with type 1a, 1b, 2a, 2b, S, M, F or A.
Physical Features	--	—·—·—	Paved highway - 2 lanes.
		=:=:=	Highway - 4 lanes or more.
		←·—·→	Bridge (highway).
		++++++++	Railroad.
		——··——··—	Levee.
		—x x—x x—	Dam.
		·····wwww	Exposed wing dam.
		—+—+—	Power line through nonforested area.
		=‡=‡=	Power line right-of-way through forested area.

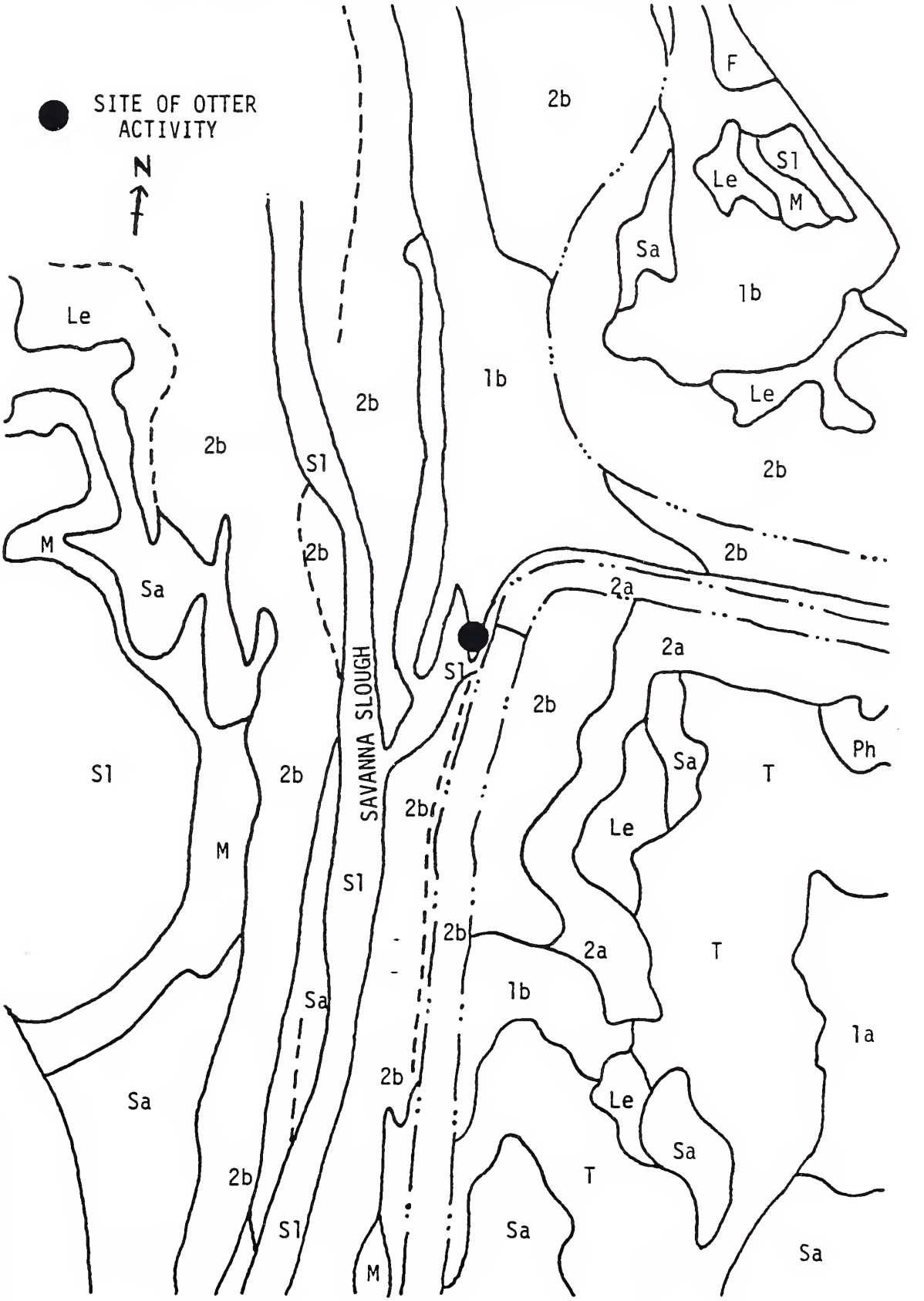
Appendix 2. Cover type mapping of the river otter intensive study area north of Fulton, Illinois (Revised from Hagem et al. 1977).



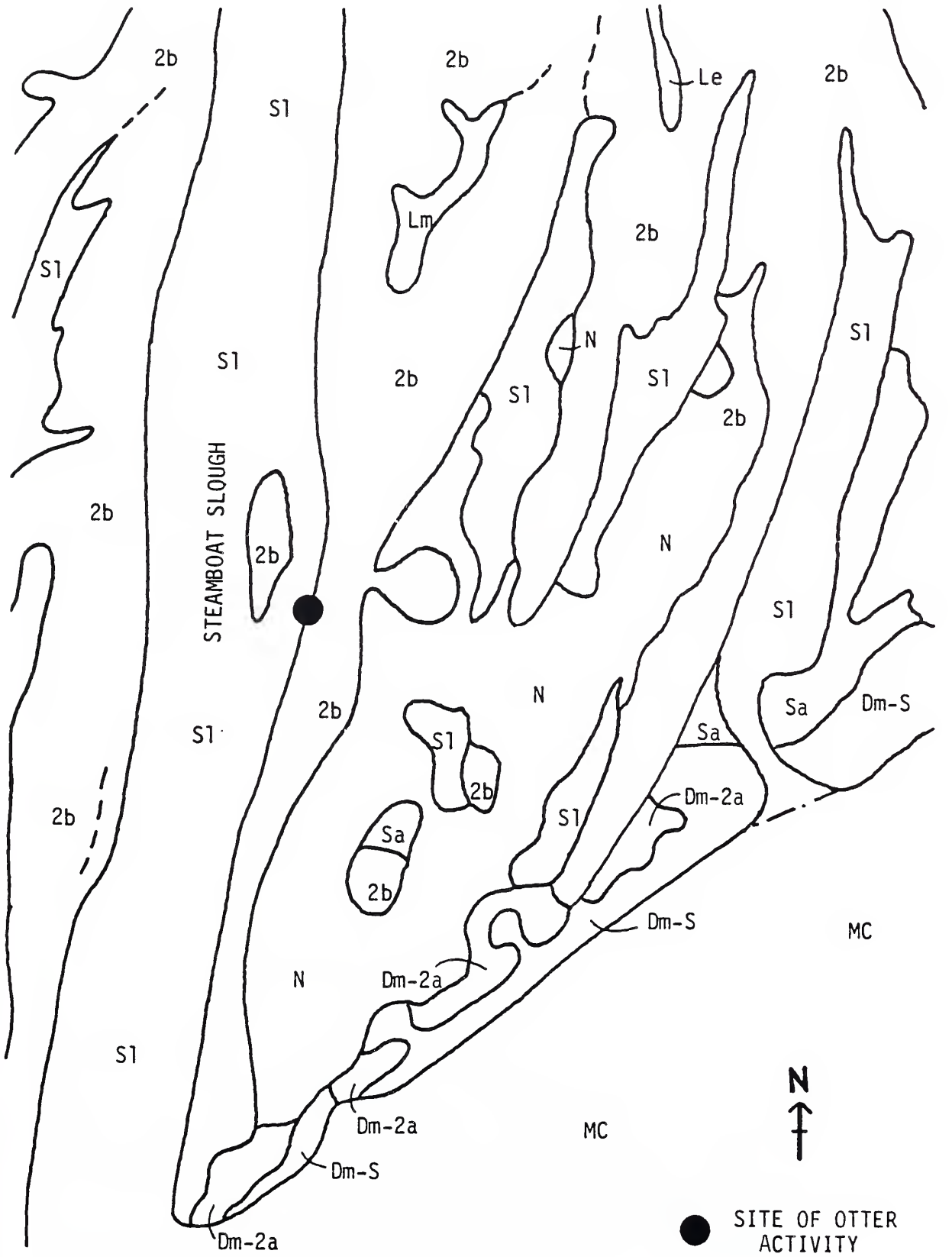
Appendix 3. Cover type mapping (1:24,000) of site of river otter activity located at the inlet of channel to Upper Brown's Lake, Iowa during winter 1982; Mississippi River miles: 545.6-546.5 (From Hagen et al. 1977).



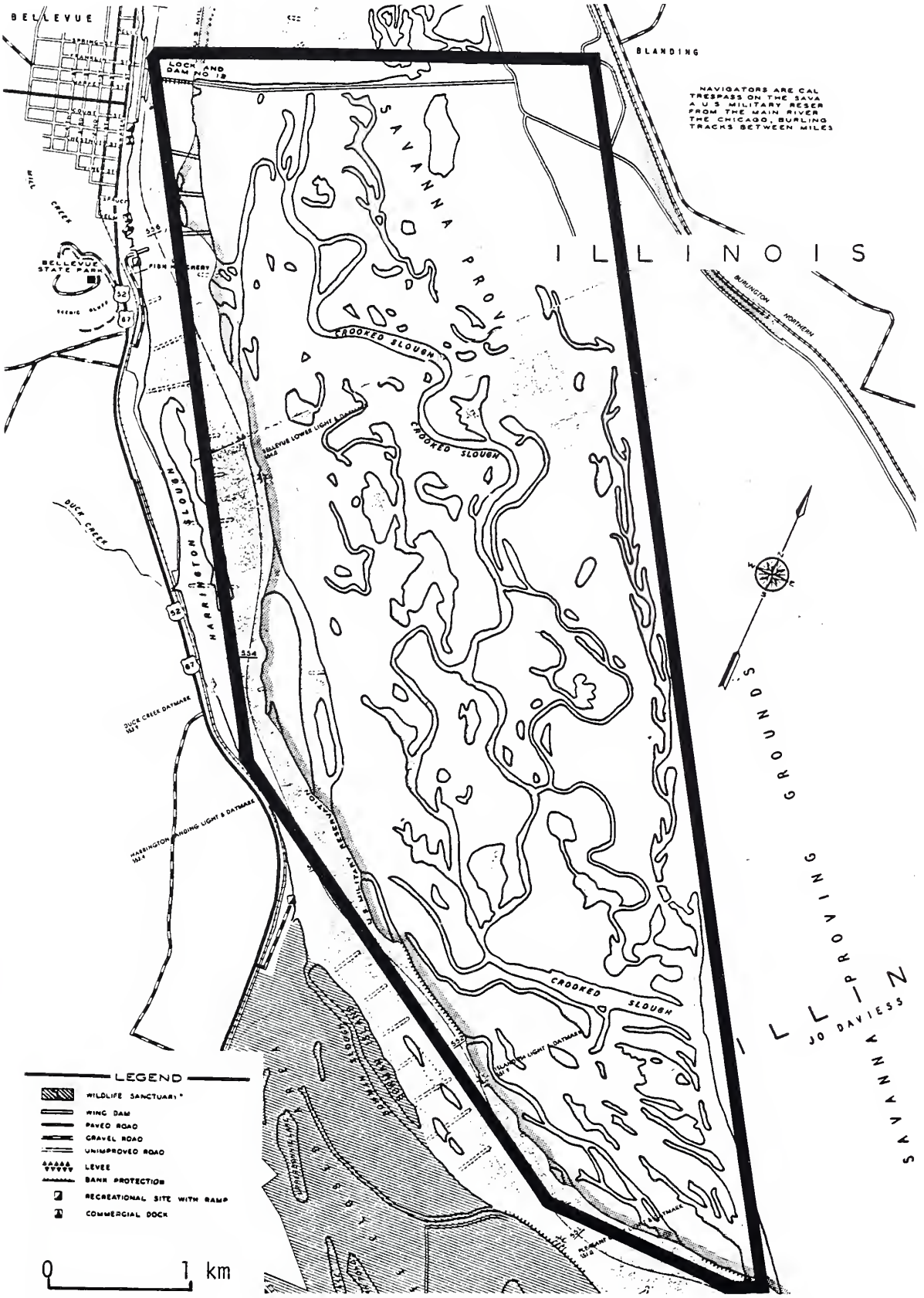
Appendix 4. Cover type mapping (1:24,000) of site of river otter activity located along Savanna Slough during winter 1982; Mississippi River miles: 535.5-536.4 (Revised from Hagen et al. 1977).



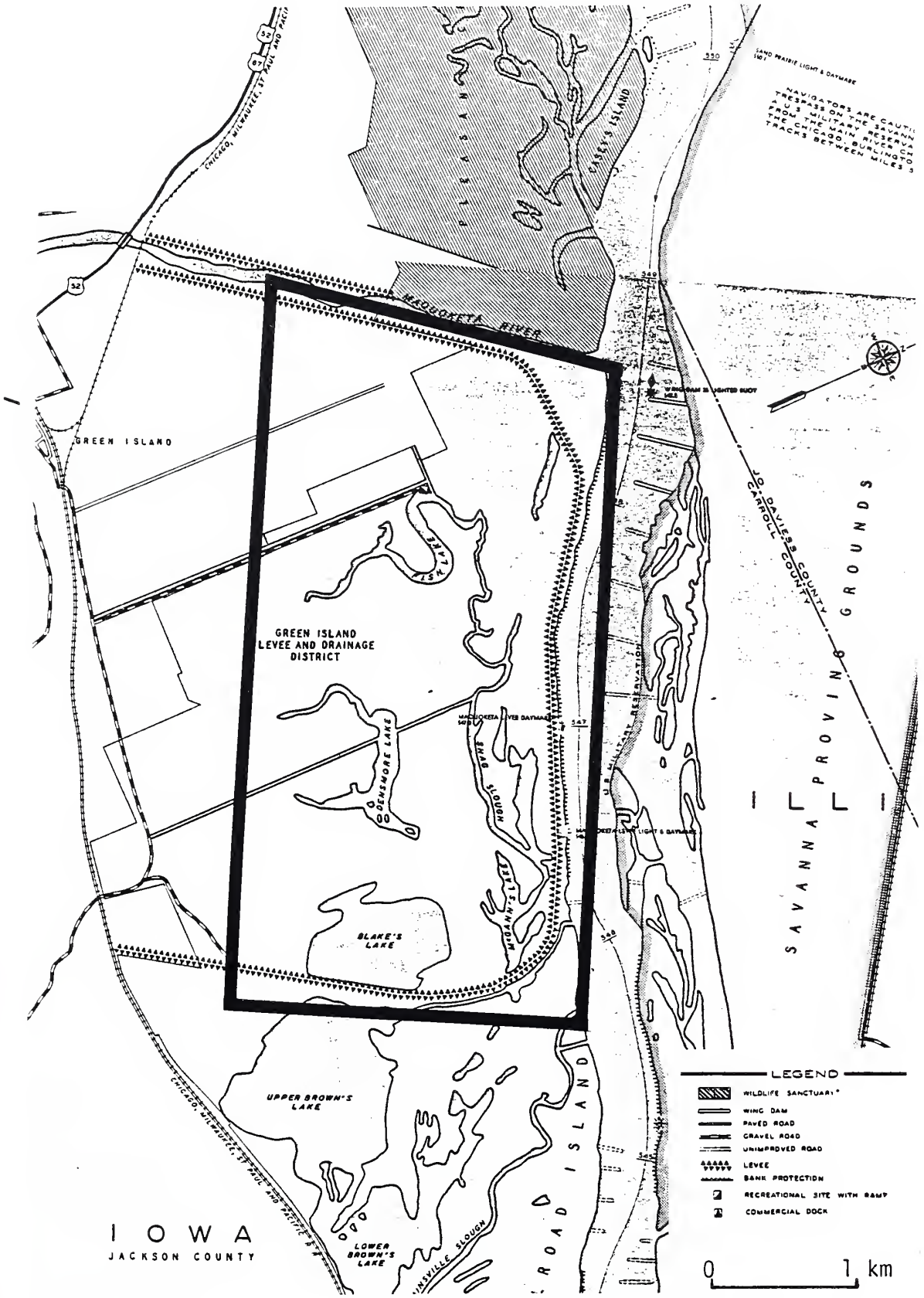
Appendix 5. Cover type mapping (1:24,000) of site of river otter activity located along Steamboat Slough, Iowa during winter 1982; Mississippi River miles: 503.5-504.6 (From Hagen et al. 1977).



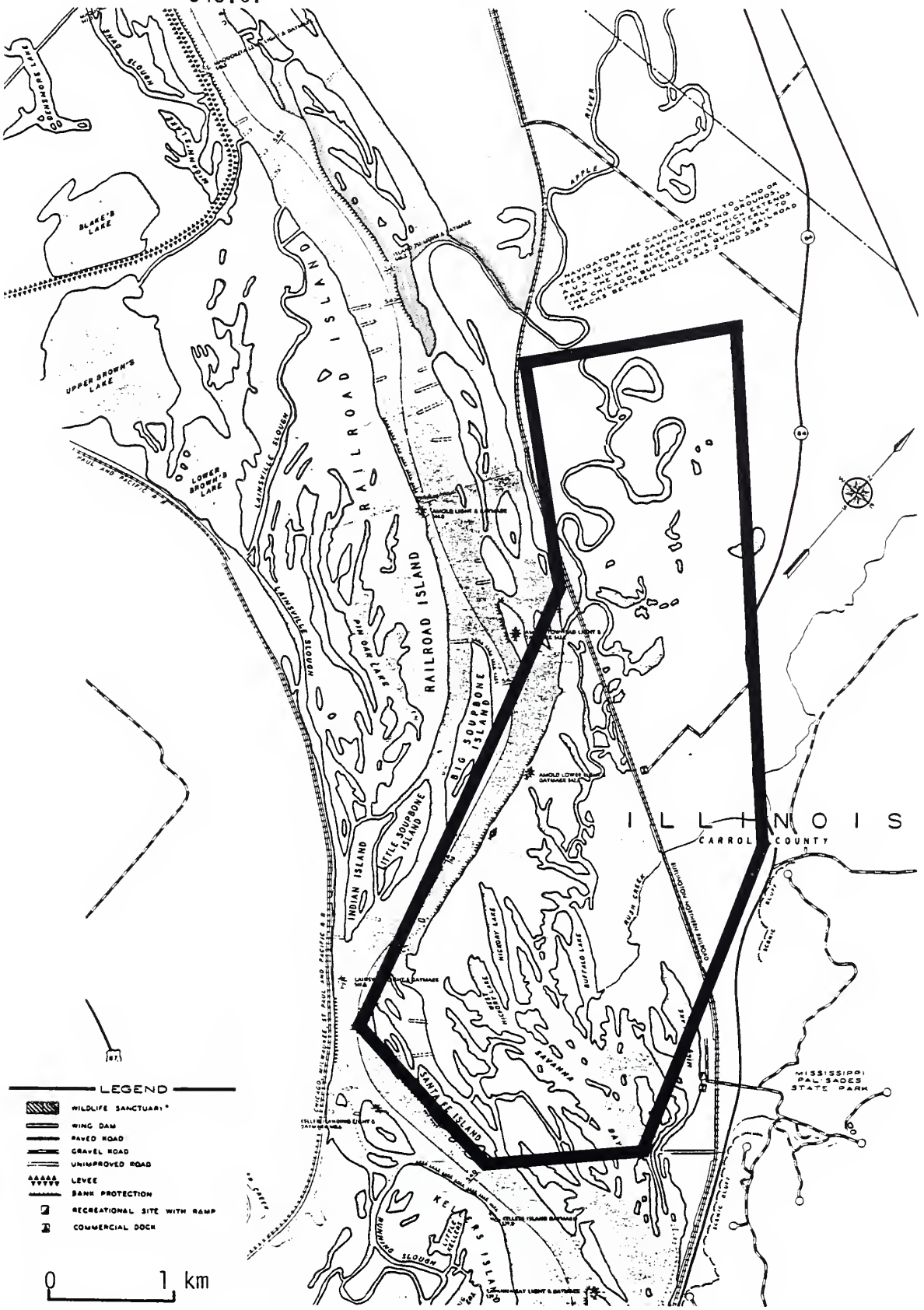
Appendix 6. Critical river otter habitat on the Savanna Proving Grounds, Mississippi River miles: 550.2-556.7.



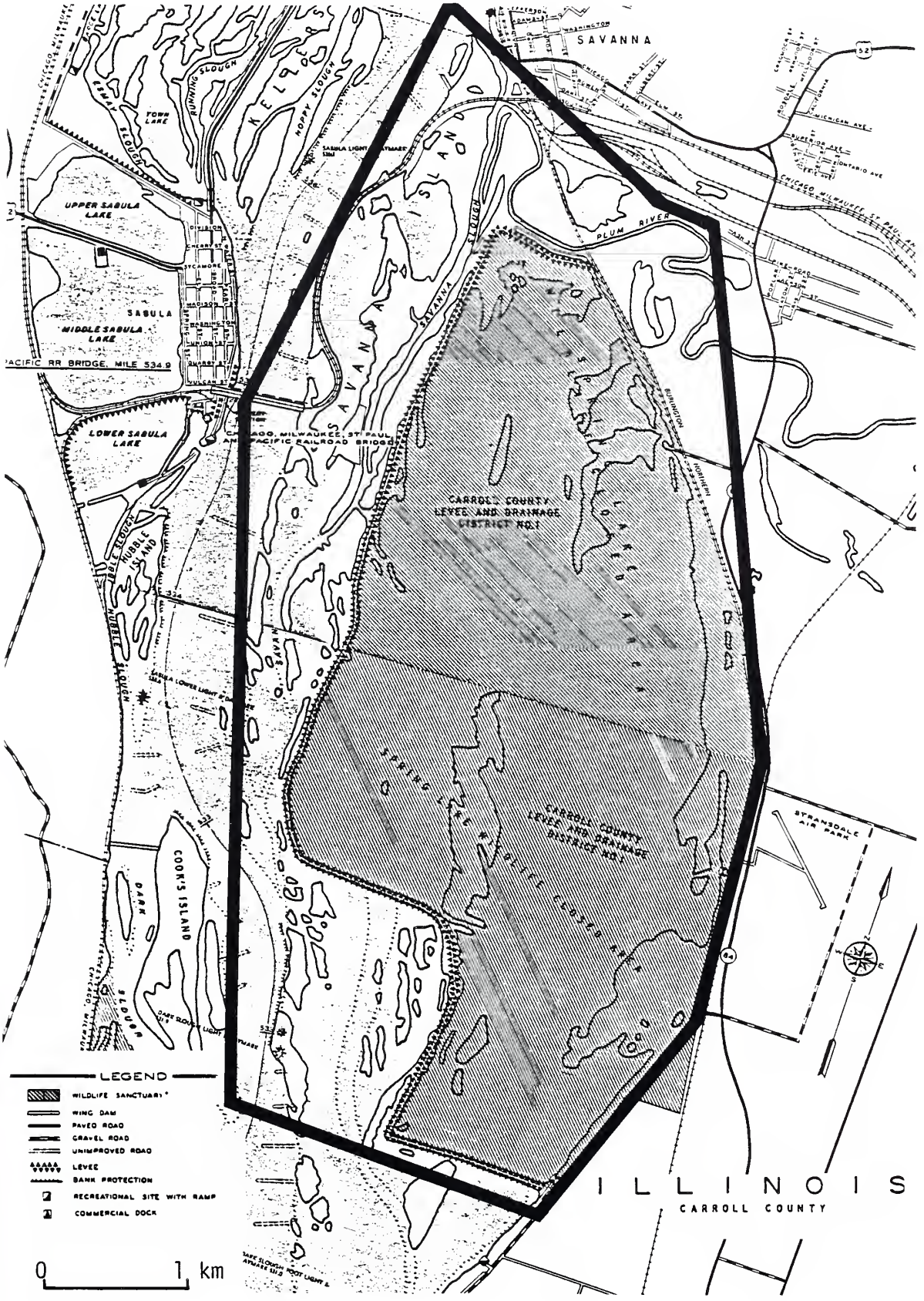
Appendix 7. Critical river otter habitat on Green Island Conservation Area, Mississippi River miles: 546.0-548.0.



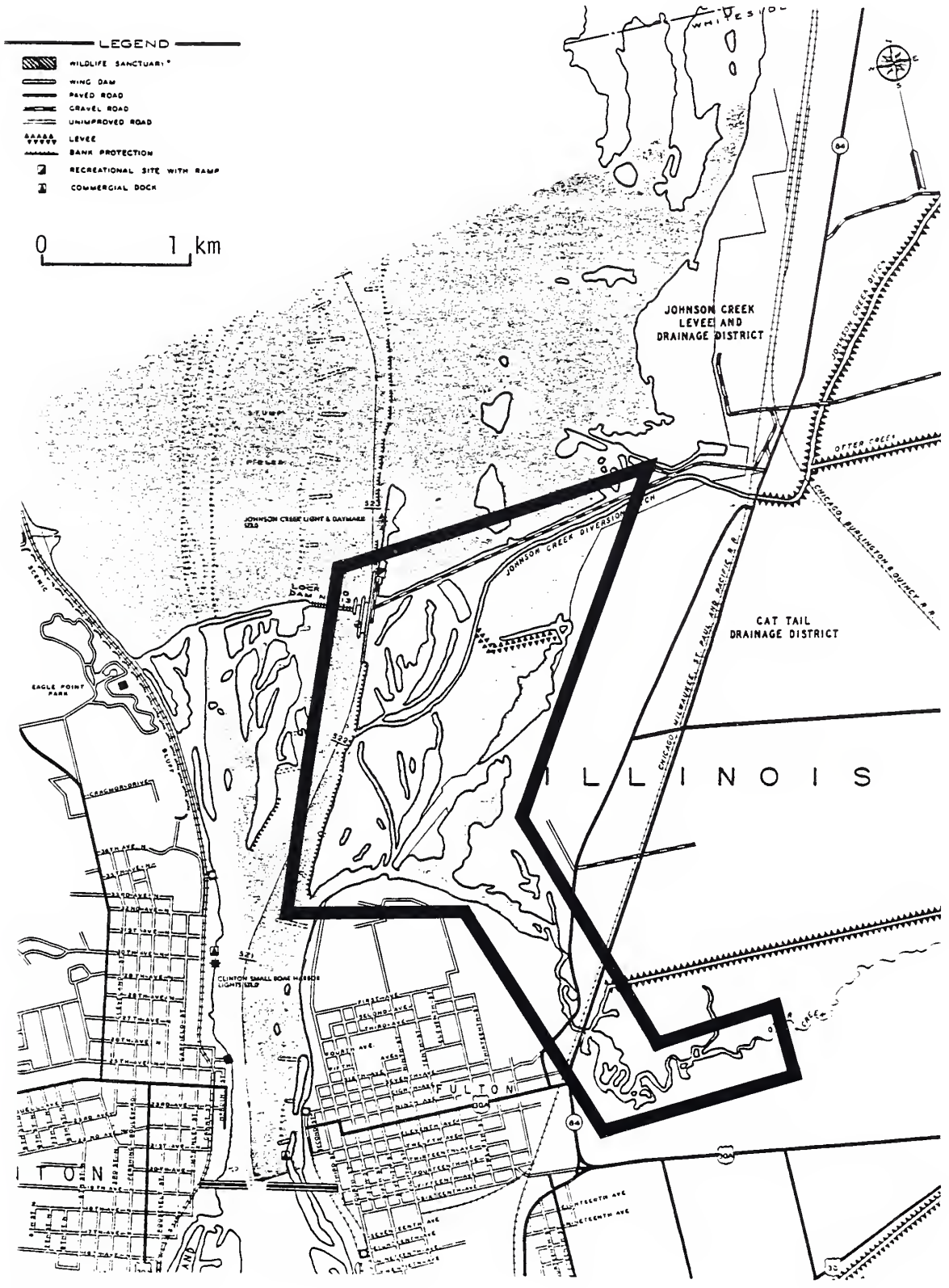
Appendix 8. Critical river otter habitat along Savanna Bay, Rush Creek, and Apple River oxbow lakes; Mississippi River miles: 540.0 -545.0.



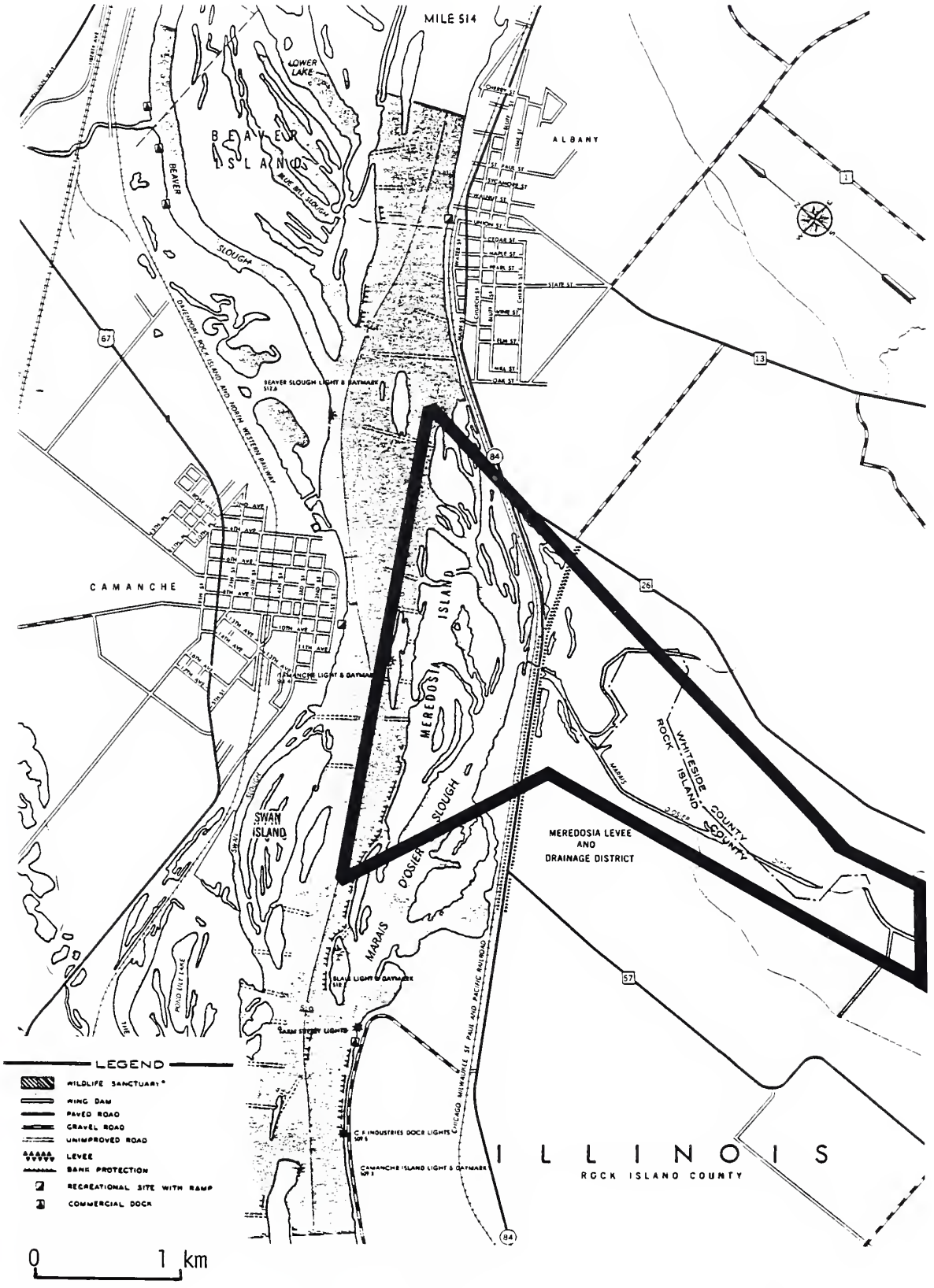
Appendix 9. Critical river otter habitat along Savanna Slough, Spring Lake, and Plum River; Mississippi River miles: 531.7-537.0.



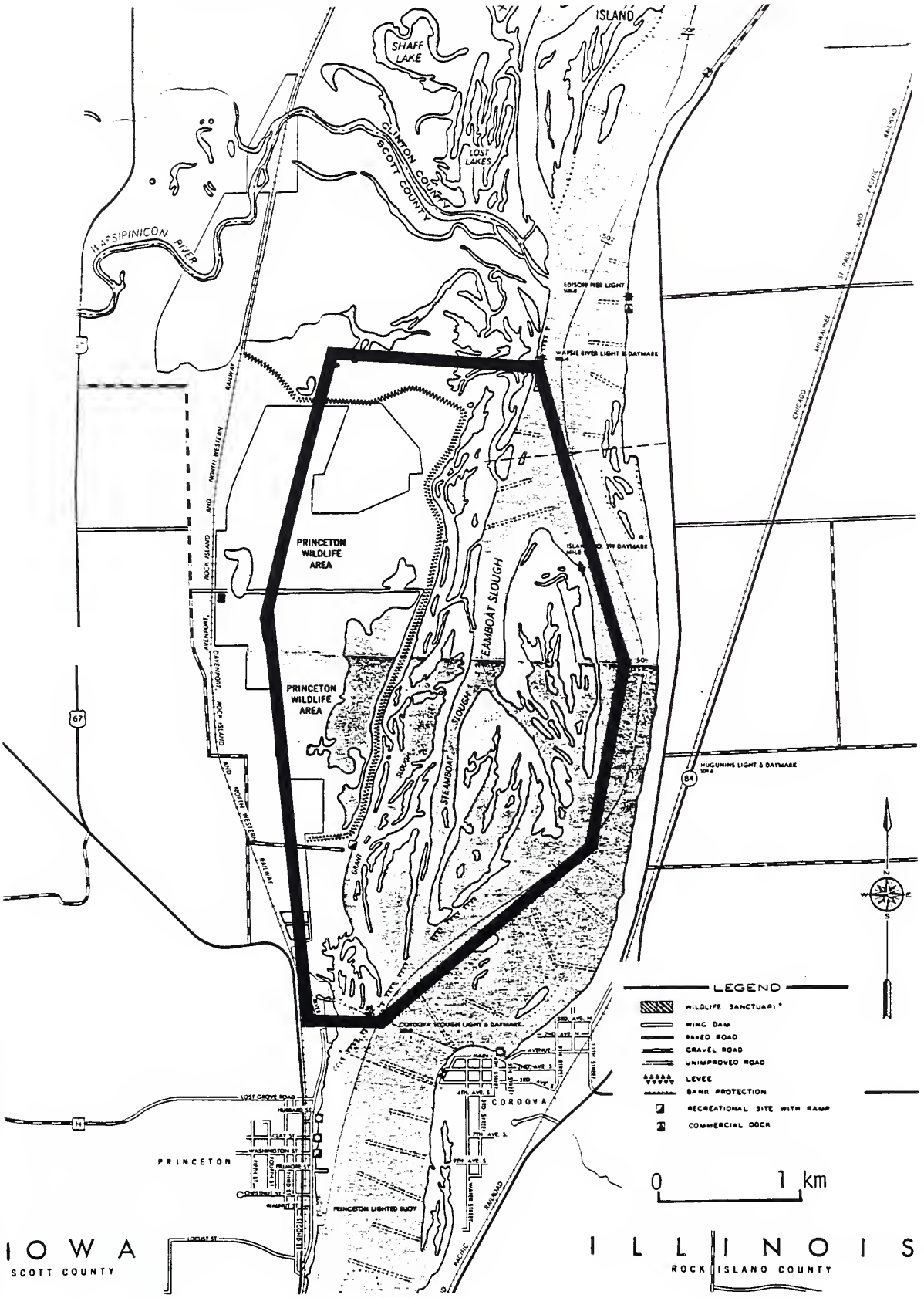
Appendix 10. Critical river otter habitat on the Lock and Dam 13 area, Johnson Creek, and Cattail Slough; Mississippi River miles: 521.0-523.0.



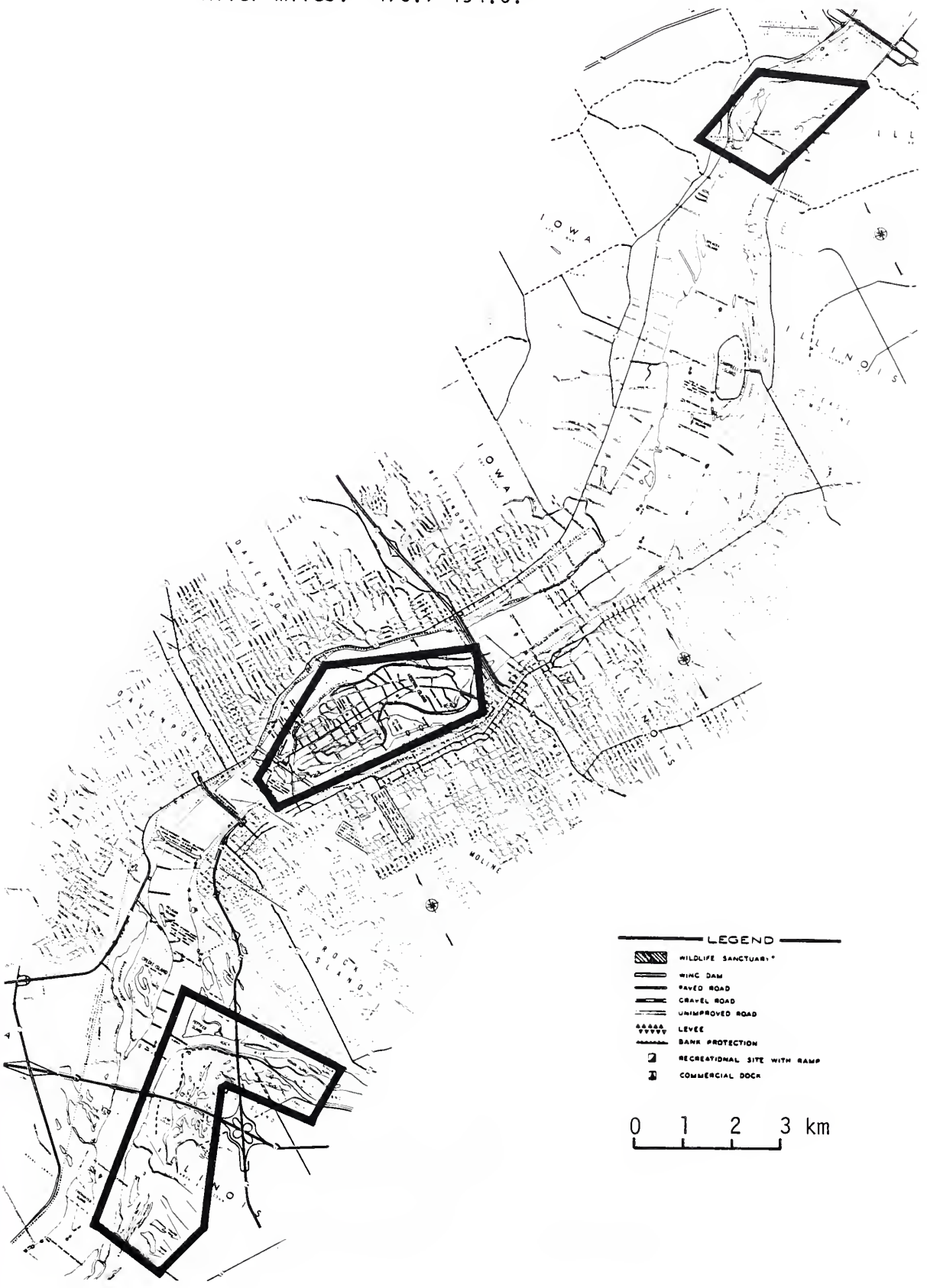
Appendix 11. Critical river otter habitat along Meredosia Island and Marais D'osier Ditch; Mississippi River miles: 510.0-512.5.



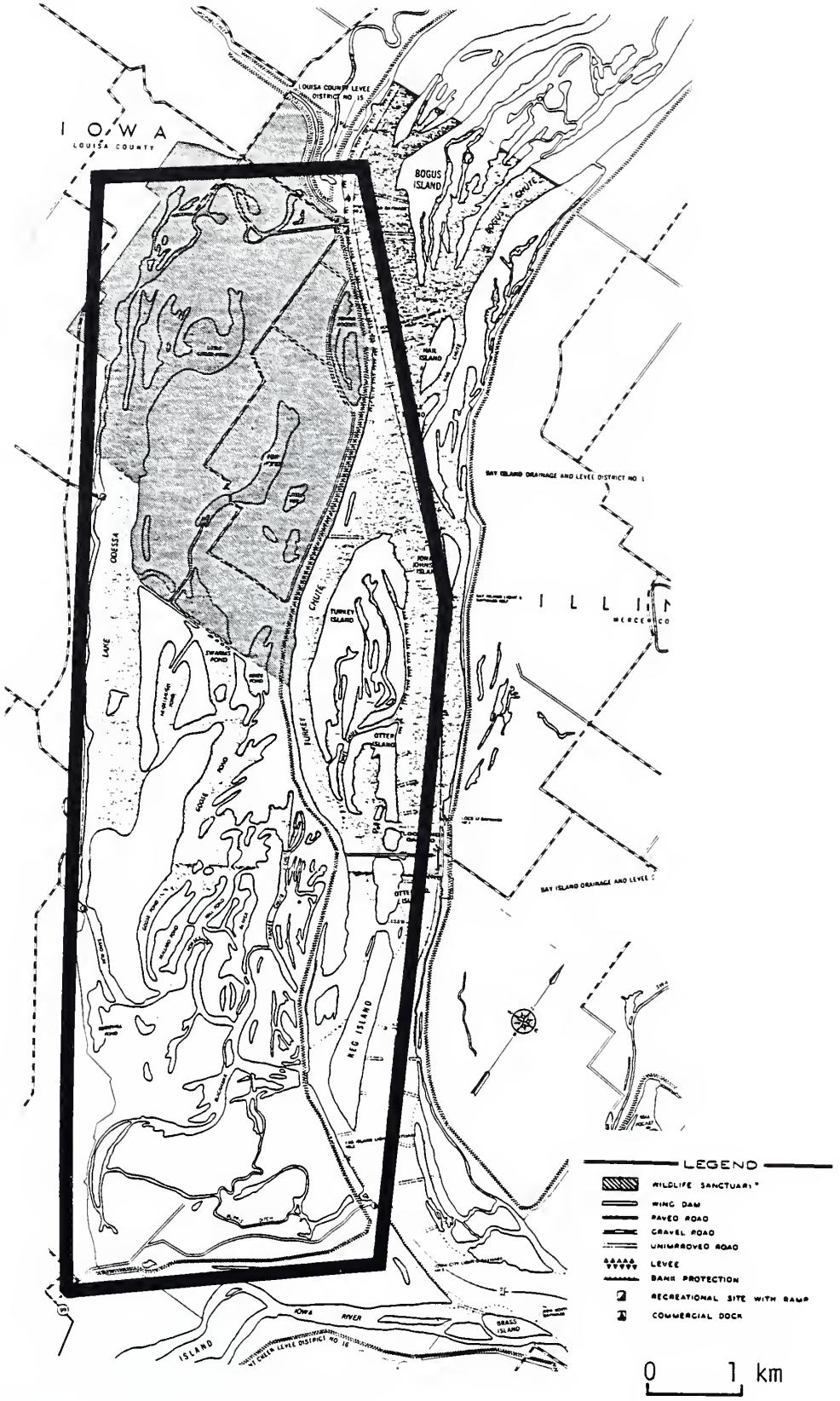
Appendix 12. Critical river otter habitat on the Princeton Wildlife Area, Grant's Slough, and Steamboat Slough; Mississippi River miles: 503.0-506.3.



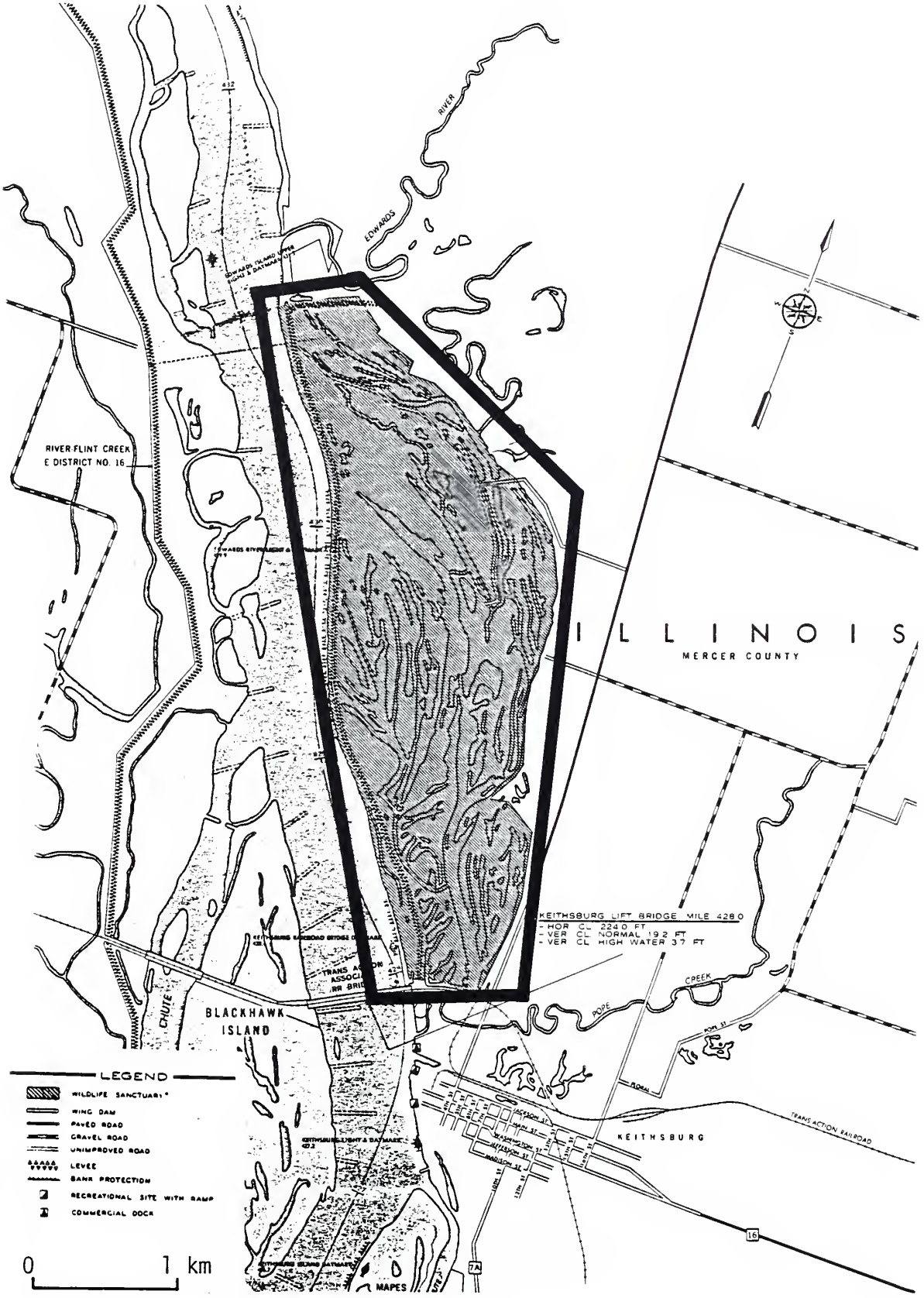
Appendix 13. Critical river otter habitat on the Lock and Dam 14 area, Arsenal Island, and Rock River mouth area; Mississippi River miles: 476.7-494.0.



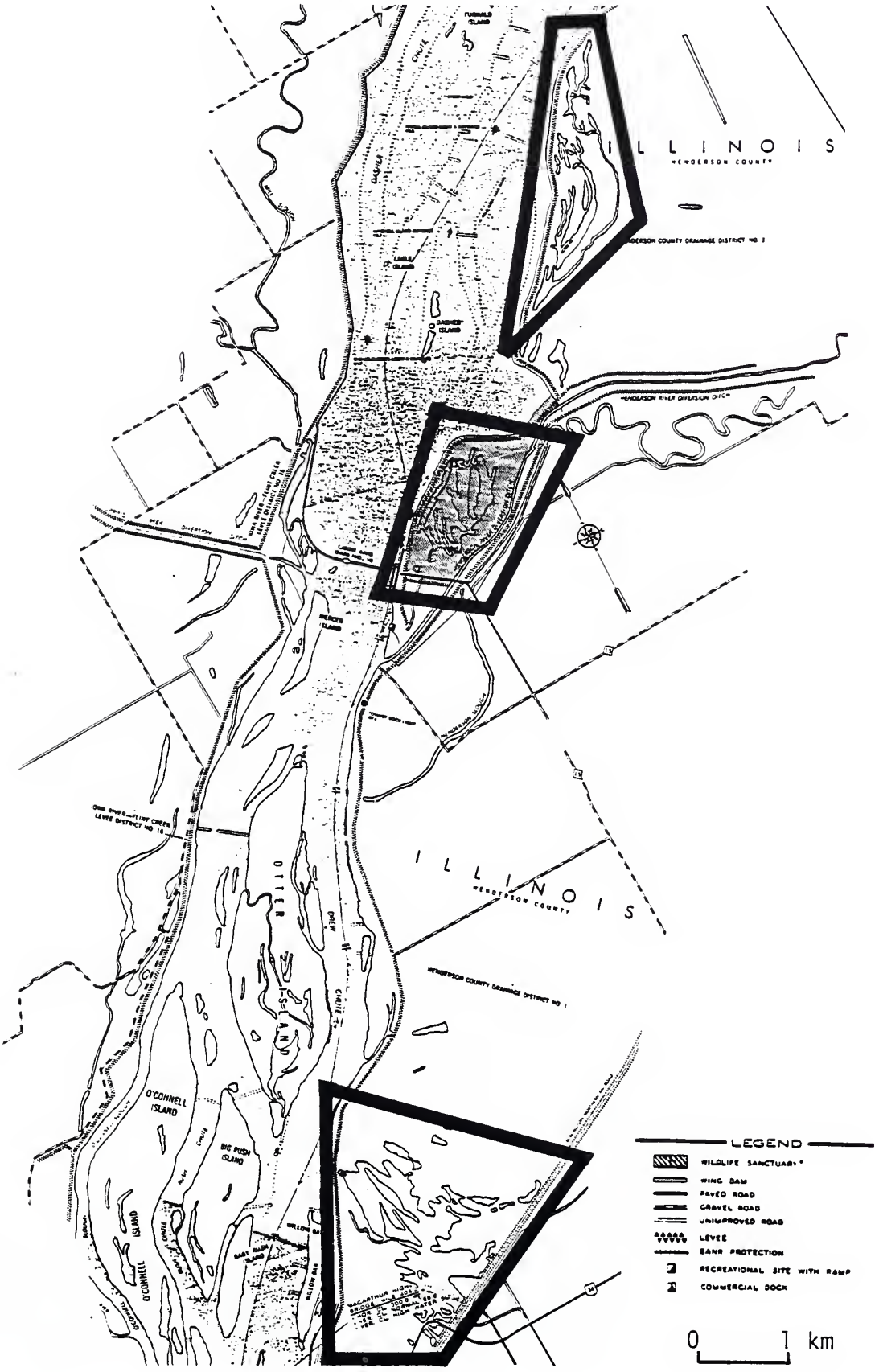
Appendix 14. Critical river otter habitat on the Lake Odessa Area, Mississippi River miles: 435.0-441.0.



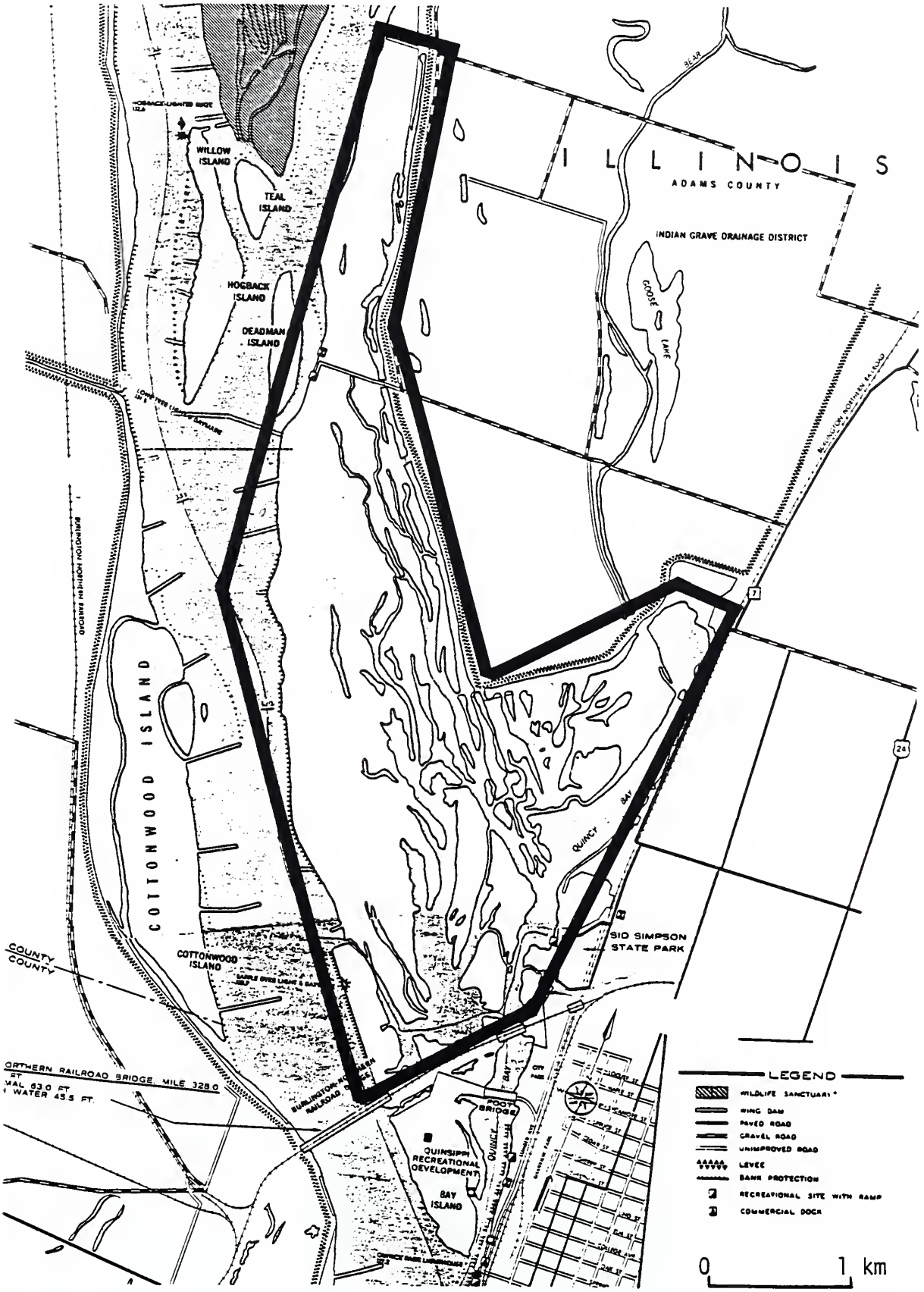
Appendix 15. Critical river otter habitat on the Keithsburg area, Mississippi River miles: 428.0-431.0.



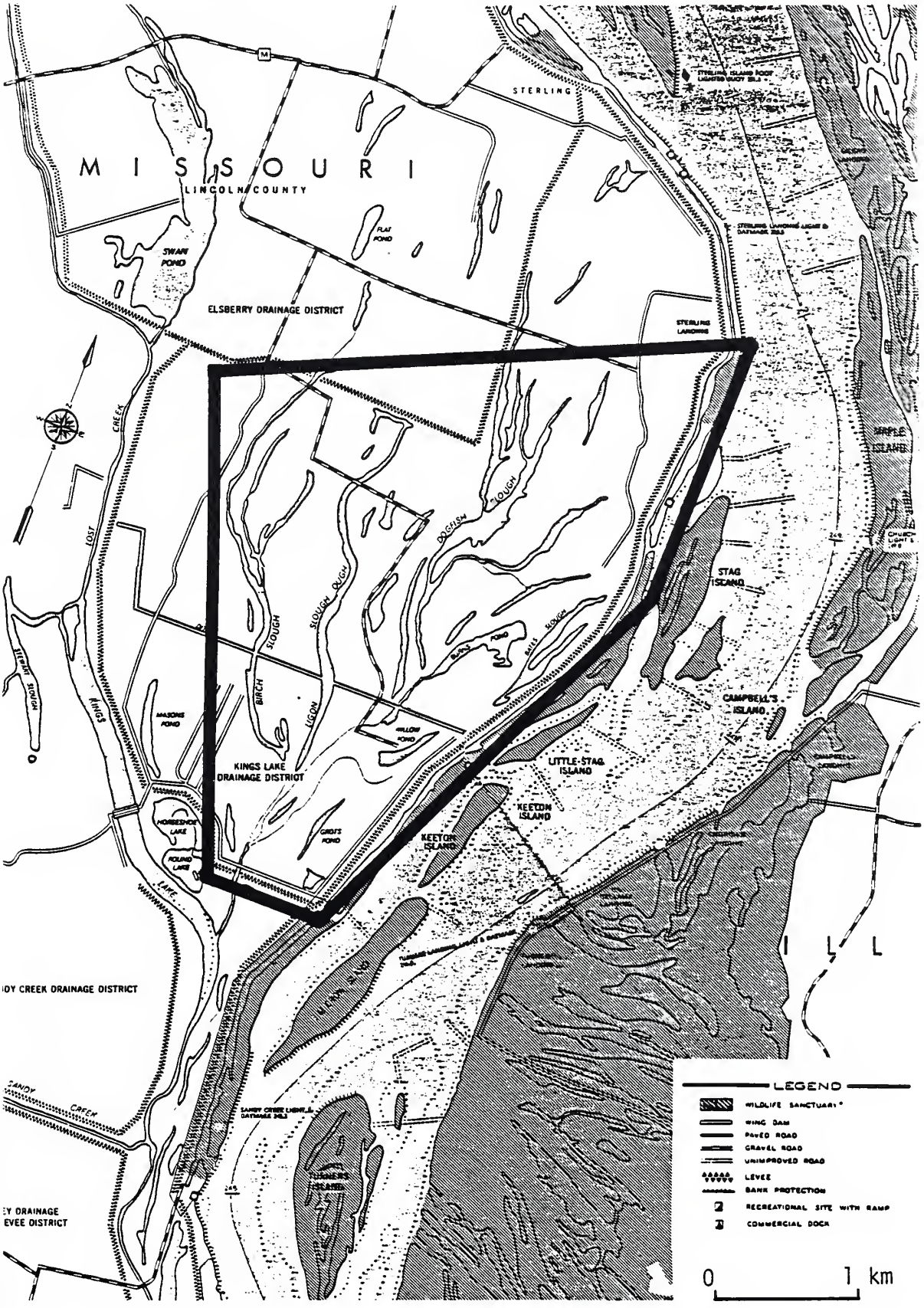
Appendix 16. Critical river otter habitat on the Lock and Dam 18 area and 2 other sites, Mississippi River miles: 405.0-414.2.



Appendix 17. Critical river otter habitat along Quincy Bay, Mississippi River miles: 328.0-332.0.



Appendix 18. Critical river otter habitat along Dogfish Slough, Ligon Slough, and Birch Slough; Mississippi River miles: 246.2 -250.0.



Appendix 19. Number of occurrences and frequency of occurrence to nearest percent per location of food items in 158 otter scats collected from the intensive study area north of Fulton, Illinois and other areas along the Mississippi River in northwestern Illinois and eastern Iowa; 1981-83.

Food Item	Study Area[1]			Savanna Slough[2]		Green Island[3]	Blind Site[4]
Sample size:	Lake 3 14	Lake 4 13	Johnson Creek 30	1982 9	1983 75	 9	 8
FISH	14(100)	10(77)	30(100)	9(100)	70(93)	9(100)	8(100)
Centrarchidae (Sunfishes)	14(100)	9(69)	20(67)	6(67)	38(51)	7(78)	3(38)
Cyprinidae (Minnows and carps)	4(29)	3(23)	14(47)	6(67)	34(45)	6(67)	5(63)
Clupeidae (Herrings)	8(57)	2(15)	19(63)	1(11)	40(53)	2(22)	5(63)
Percichthyidae (Temperate basses)	2(14)	- -	9(30)	- -	18(24)	6(67)	1(13)
Esocidae (Pikes)	1(7)	3(23)	1(3)	- -	- -	- -	1(13)
Percidae (Darters and perches)	- -	1(8)	4(13)	- -	- -	- -	- -
Amiidae (Bowfins)	- -	- -	1(3)	- -	- -	- -	- -
Catostomidae (Suckers)	- -	1(8)	3(10)	1(11)	2(3)	3(33)	- -
Unidentified fish	- -	- -	1(3)	- -	2(3)	3(33)	- -
AMPHIBIANS							
Frog (*Rana* spp.)	3(21)	6(46)	7(23)	- -	2(3)	2(22)	- -
CRUSTACEANS							
Crayfish (Cambarus spp.)	2(14)	5(38)	6(20)	1(11)	14(19)	3(33)	1(13)
INSECTS							
Dragonfly nymph (Odonata)	- -	- -	- -	- -	1(1)	- -	- -
BIRDS (Unidentified)	- -	2(15)	- -	- -	- -	- -	- -

[1] Scats collected on intensive study area north of Fulton, Illinois; November 1981 - February 1982.

[2] Scats collected along Savanna Slough, 1.6 km south of Savanna, Illinois; February 1982, February - June 1983.

[3] Scats collected east of Green Island Conservation Area at the inlet of channel to Upper Brown's Lake Iowa: February 1982.

[4] Scats collected near Blind Site 54, 4.8 km north of Fulton, Illinois; March 1983.

Appendix 20. Number of occurrences and frequency of occurrence to nearest percent per location of fish collected during fish surveys in the river otter intensive study area north of Fulton, Illinois (I.D.O.C., unpubl. data).

Species	Sample size:	Lake 3[1] 496	Lake 5[2] 251	Miss. R.[3] 238	Total 985
Centrarchidae (Sunfishes)		213(43)	21(8)	65(27)	299(30)
Rock bass (Ambloplites rupestris)		- -	- -	1(1)	1(1)
Orangespotted sunfish (Lepomis humilis)		4(1)	- -	- -	4(1)
Hybrid sunfish (Lepomis spp.)		1(1)	1(1)	1(1)	3(1)
Bluegill (Lepomis macrochirus)		100(20)	5(2)	30(13)	135(14)
Smallmouth bass (Micropterus dolomieui)		- -	- -	1(1)	1(1)
Largemouth bass (Micropterus salmoides)		30(6)	2(1)	10(4)	42(4)
White crappie (Pomoxis annularis)		37(7)	10(4)	7(3)	54(5)
Black crappie (Pomoxis nigromaculatus)		41(8)	3(1)	15(6)	59(6)
Clupeidae (Herrings)					
Gizzard shad (Dorosoma cepedianum)		130(26)	58(23)	82(34)	270(27)
Cyprinidae (Minnows and carps)		108(22)	46(18)	18(8)	172(17)
Carp (Cyprinus carpio)		100(20)	46(18)	18(8)	164(17)
Emerald shiner (Notropis anterinoides)		4(1)	- -	- -	4(1)
Pugnose minnow (Notropis emiliae)		1(1)	- -	- -	1(1)
Spottail shiner (Notropis hudsonius)		2(1)	- -	- -	2(1)
Bullhead minnow (Pimephales vigilax)		1(1)	- -	- -	1(1)
Percichthyidae (Temperate basses)					
White bass (Morone chrysops)		16(3)	41(16)	54(23)	111(11)
Ictaluridae (Freshwater catfishes)		- -	57(23)	2(1)	59(6)
Black bullhead (Ictalurus melas)		- -	57(23)	- -	57(6)
Channel catfish (Ictalurus punctatus)		- -	- -	1(1)	1(1)
Flathead catfish (Pylodictis olivaris)		- -	- -	1(1)	1(1)
Catostomidae (Suckers)		10(2)	10(4)	4(2)	24(5)
River carpsucker (Carpiodes carpio)		1(1)	3(1)	1(1)	5(1)
Quillback (Carpiodes cyprinus))		2(1)	1(1)	- -	3(1)
White sucker (Catostomus commersoni)		- -	1(1)	- -	1(1)
Smallmouth buffalo (Ictiobus bubalus)		3(1)	2(1)	- -	5(1)
Bigmouth buffalo (Ictiobus cyprinellus)		3(1)	1(1)	3(1)	7(1)
Spotted sucker (Minytrema melanops)		1(1)	2(1)	- -	3(1)
Hiodontidae (Mooneyes)					
Mooneye (Hiodon tergisus)		- -	6(2)	7(3)	13(1)
Percidae (Darters and perches)		3(1)	4(2)	5(2)	12(1)
Yellow perch (Perca flavescens)		- -	3(1)	- -	3(1)
Sauger (Stizostedion canadense)		1(1)	- -	1(1)	2(1)
Walleye (Stizostedion viteum)		2(1)	1(1)	4(2)	7(1)
Atherinidae (Silversides)					
Brook silverside (Labidesthes sicculus)		12(2)	- -	- -	12(1)
Esocidae (Pikes)					
Northern pike (Esox lucius)		- -	8(3)	- -	8(1)
Scaenidae (Drums)					
Freshwater drum (Aplodinotus grunniens)		3(1)	- -	1(1)	4(1)
Amiidae (Bowfins)					
Bowfin (Amia calva)		1(1)	- -	- -	1(1)

[1] Survey method: electrofishing (60 minutes); 1980, 1981, and 1982.

[2] Survey methods: 2 trap nets (36 hours), 46 m gill net (18 hours), and electrofishing (30 minutes); 1972.

[3] Survey method: electrofishing (60 minutes); 1970.

Appendix 21. Necropsy data from 9 river otters collected in Illinois, 1981-83.

Report Number[1]	County/ Location	Sex	Weight (kg)	Total Length (mm)	Tail Length (mm)	Hind Foot Length (mm)	Ear Length (mm)	Cause of Death
CW81-6	Hancock T5N-R8W-S19	Male	9.0	1150	432	131	21	Drowned in trammel net (commercial fishing)
CW82-2	Whiteside T22N-R3E-S22	Female	5.9	920	350	116	21	Caught by trapper
CW82-16	Mercer T14N-R6W-S36	Male	11.1	1181	462	125	24	Drowned in gill net (commercial fishing)
CW82-46	Pope T11S-R5E-S26	Male	4.1	932	332	115	17	Road-kill
CW82-49	Jo Daviess T27N-R1E-S28	Male	6.4	1001	360	127	20	Caught by trapper
CW82-50	Whiteside T22N-R3E-S21	Female	5.4	950	330	111	20	Caught by trapper
CW83-17	Fayette T59-R4E-S28	Male	10.5	1185	430	128	22	Road-kill
CW83-30	Woodford T28N-R3E-S?	Male	9.7	1192	435	140	24	Road-kill
CW83-31	Whiteside T21N-R2E-S35	Male	10.8	1238	455	135	23	Road-kill

[1] Necropsy reports on file at the CWRL.

Appendix 22. Results of heavy metal analysis of 4 river otters collected in Illinois, 1982-83.

Report Number[1]	Organ	Element (ppm dry weight)							
		CD	CO	CU	MG	MN	NI	PB	PB
CW82-46	Liver	000	000	32.00	400.05	6.42	22.86	000	17.31
	Kidney	004	000	8.99	334.67	2.65	6.32	000	5.81
CW82-49	Liver	000	000	13.87	328.39	5.56	0.00	000	5.46
	Kidney	000	000	5.08	347.48	1.91	0.00	000	3.52
CW82-50	Liver	001	000	9.61	369.61	4.69	1.40	000	8.74
	Kidney	024	000	4.58	255.31	1.39	0.00	000	14.99
CW83-17	Liver	012	000	5.77	313.00	6.20	0.00	000	42.43
	Kidney	070	000	6.08	316.00	1.92	0.00	000	15.04

[1] Necropsy reports on file at the CWRL.

Appendix 23. Maximum Mississippi River stage during March and April recorded at Clinton, Iowa; river mile: 518.0; 1933-83 (Rock Island District, U.S. Army Corps of Engineers, unpubl. data).